



Search for Supersymmetry in Events with Three Leptons and Missing Transverse Momentum in $\sqrt{s} = 7$ TeV pp Collisions with the ATLAS Detector

G. Aad *et al.**

(ATLAS Collaboration)

(Received 25 April 2012; published 29 June 2012)

A search for the weak production of charginos and neutralinos decaying to a final state with three leptons (electrons or muons) and missing transverse momentum is presented. The analysis uses 2.06 fb^{-1} of $\sqrt{s} = 7$ TeV proton-proton collision data delivered by the Large Hadron Collider and recorded with the ATLAS detector. Observations are consistent with standard model expectations in two signal regions that are either depleted or enriched in Z -boson decays. Upper limits at 95% confidence level are set in R -parity conserving phenomenological minimal supersymmetric and simplified models. For the simplified models, degenerate lightest chargino and next-to-lightest neutralino masses up to 300 GeV are excluded for mass differences from the lightest neutralino up to 300 GeV.

DOI: [10.1103/PhysRevLett.108.261804](https://doi.org/10.1103/PhysRevLett.108.261804)

PACS numbers: 14.80.Ly, 14.80.Nb, 12.60.Jv

Supersymmetric (SUSY) extensions [1–9] of the standard model (SM) naturally address the gauge hierarchy problem [10–12] by postulating the existence of SUSY particles, or “sparticles”, with spin differing by one-half unit with respect to that of their SM partner. If R -parity [13–17] is conserved, sparticles can only be pair-produced and will eventually decay into SM particles and the lightest SUSY particle (LSP) which is stable. Charginos ($\tilde{\chi}_i^\pm$, $i = 1, 2$) and neutralinos ($\tilde{\chi}_j^0$, $j = 1, 2, 3, 4$) are the mass eigenstates formed from the linear superposition of the SUSY partners of the Higgs and electroweak gauge bosons. These are the Higgsinos, and the winos, zino, and bino, collectively known as gauginos. Naturalness requires $\tilde{\chi}_i^\pm$ and $\tilde{\chi}_j^0$ (and third-generation sparticles) to have masses in the hundreds of GeV range [18]. In scenarios where first and second generation sfermion masses are larger than few TeVs, the direct production of weak gauginos may be the dominant SUSY process at the Large Hadron Collider (LHC).

Leptonic decays of charginos include sneutrinos ($\tilde{\nu}\ell^\pm$), sleptons ($\tilde{\ell}^\pm\nu$) or W bosons ($W^{\pm(*)}\tilde{\chi}_1^0$), while those of unstable neutralinos include sleptons ($\ell\tilde{\ell}^\pm$) or Z bosons ($Z^{(*)}\tilde{\chi}_1^0$). When both gauginos decay leptonically, a distinctive signature with three leptons and significant missing transverse momentum can be observed, the latter originating from the two undetected LSPs and the neutrinos.

This Letter presents the first search with the ATLAS detector for the weak production of charginos and neutralinos decaying to a final state with three leptons (electrons or muons) and missing transverse momentum. The analysis

is based on 2.06 fb^{-1} of proton-proton collision data delivered by the LHC at a center-of-mass energy $\sqrt{s} = 7$ TeV between March and August 2011. The search significantly extends the current mass limits on charginos and neutralinos [19–22] and yields sensitivity in the mass region preferred by naturalness.

In this analysis, observations are interpreted in the phenomenological minimal supersymmetric SM (pMSSM [23]) and in simplified models [24]. In the pMSSM the masses of the $\tilde{\chi}_i^\pm$ and $\tilde{\chi}_j^0$ depend on the gaugino masses M_1 and M_2 , the Higgs mass parameter $|\mu|$, and $\tan\beta$, the ratio of the expectation values of the two Higgs doublets. The masses of the gluinos, squarks and left-handed sleptons are chosen to be larger than 1 TeV, while the right-handed sleptons (including third-generation ones) are assumed to be degenerate with $m_{\tilde{\ell}_R} = (m_{\tilde{\chi}_2^0} + m_{\tilde{\chi}_1^0})/2$. In these scenarios, decays to sleptons are favored. In the simplified models, the masses of the relevant particles (mass degenerate winolike $\tilde{\chi}_1^\pm$ and $\tilde{\chi}_2^0$; binolike $\tilde{\chi}_1^0$; $\tilde{\nu}$; $\tilde{\ell}_L$) are the only free parameters of the theory. The $\tilde{\chi}_1^\pm$ and $\tilde{\chi}_2^0$ are produced via the s -channel exchange of a virtual gauge boson and decay via left-handed sleptons, including staus, and sneutrinos of mass $m_{\tilde{\nu}} = m_{\tilde{\ell}_L} = (m_{\tilde{\chi}_1^0} + m_{\tilde{\chi}_1^\pm})/2$ with a branching ratio of 50% each.

ATLAS [25] is a multipurpose particle detector with forward-backward symmetric cylindrical geometry. It includes an inner tracker (ID) immersed in a 2 T magnetic field providing precision tracking of charged particles for pseudorapidities $|\eta| < 2.5$ [26]. Calorimeter systems with either liquid argon or scintillating tiles as the active media provide energy measurements over the range $|\eta| < 4.9$. The muon detectors outside the calorimeters are contained in a toroidal magnetic field produced by air-core superconducting magnets with field integrals varying from 1 to 8 T · m. They provide trigger and high-precision tracking capabilities for $|\eta| < 2.4$ and $|\eta| < 2.7$, respectively.

*Full author list given at the end of the article.

Published by the American Physical Society under the terms of the [Creative Commons Attribution 3.0 License](https://creativecommons.org/licenses/by/3.0/). Further distribution of this work must maintain attribution to the author(s) and the published article's title, journal citation, and DOI.

Electrons must satisfy tight identification criteria and fulfil $|\eta| < 2.47$ and $E_T > 10$ GeV, where $|\eta|$ and E_T are determined from the calibrated clustered energy deposits in the electromagnetic calorimeter matched to an ID track. Muons are reconstructed by combining tracks in the ID and tracks in the muon spectrometer [27]. Reconstructed muons are considered as candidates if they have transverse momentum $p_T > 10$ GeV, $|\eta| < 2.4$, and transverse impact parameter with respect to the primary vertex $|d_0| < 0.2$ mm. “Tagged” leptons are electrons and muons, well separated from each other and from candidate jets. “Signal” leptons are tagged leptons for which the scalar sum of the tracks’ transverse momenta within $\Delta R \equiv \sqrt{(\Delta\phi)^2 + (\Delta\eta)^2} < 0.2$ around the lepton candidate is less than 10% of the E_T for electrons, and less than 1.8 GeV for muons. Jets are reconstructed from clustered energy deposits calibrated at the electromagnetic scale using the anti- k_t algorithm [28] with a radius parameter of 0.4. The jet energy is corrected to account for the non-compensating nature of the calorimeter using correction factors obtained from Monte Carlo (MC) simulation and parameterized as a function of the jet E_T and η [29]. Jets considered in this analysis have $E_T > 20$ GeV and $|\eta| < 2.8$. Jets are identified as containing a b -quark, and thus called “ b -tagged”, using a multivariate technique based on quantities such as the impact parameter of the tracks associated to the secondary vertex, tracks in jet and other jet shape information, consistent with the expected topology of b -quark decays. The b -tagging algorithm [30] correctly identifies b -quark jets in top decays with an efficiency of 60% and misidentifies jets containing light-flavor quarks and gluons with a rate of $< 1\%$, for jets with $|\eta| < 2.5$ and jet $E_T > 20$ GeV. The missing transverse momentum, E_T^{miss} , is the magnitude of the vector sum of the transverse momentum or transverse energy of all $p_T > 10$ GeV muons, $E_T > 10$ GeV electrons, $E_T > 20$ GeV jets, and calibrated calorimeter clusters with $|\eta| < 4.5$ not associated to these objects [31].

Several MC generators are used to simulate SM processes and SUSY signals relevant for this analysis. HERWIG [32] is used to simulate diboson processes ($WW^{(*)}$, $ZZ^{(*)}$, $WZ^{(*)}$), while MADGRAPH [33] is used for the $t\bar{t}W^{(*)}/Z^{(*)}$ processes. MC@NLO [34] is chosen for the simulation of single and pair production of top quarks, while ALPGEN [35] is used to simulate $W^{(*)}/Z^{(*)} + \text{jets}$. Expected diboson yields are normalized using next-to-leading order (NLO) QCD predictions obtained with MCFM [36,37]. The top-quark pair-production contribution is normalized to approximate next-to-next-to-leading (NNLO) order calculations [38] and the $t\bar{t}W^{(*)}/Z^{(*)}$ contributions are normalized to NLO results [39]. The QCD NNLO FEWZ [40,41] and MCFM cross-sections are used for NNLO normalization of the $Z + \text{light-flavor jets}$ and $Z + \text{heavy-flavor jets}$ processes, respectively. The choice of the parton distribution functions (PDFs) depends on the generator. MRST

2007 LO* [42] sets are used for HERWIG, CTEQ6L1 [43] with MADGRAPH and ALPGEN, and CTEQ6.6 [44] with MC@NLO. The pMSSM and simplified model samples are produced with HERWIG and HERWIG++ [45], respectively, and the yields are normalized to the NLO cross-sections obtained from PROSPINO [46] using the PDF set CTEQ6.6 with the renormalization/factorization scales set to the average of the relevant gaugino masses. Fragmentation and hadronization for the ALPGEN and MC@NLO (MADGRAPH) samples are performed with HERWIG (PYTHIA [47]). For all MC samples, the propagation of particles through the ATLAS detector is modeled using GEANT4 [48,49]. The effect of multiple proton-proton collisions from the same or different bunch crossings is incorporated into the simulation by overlaying additional minimum bias events onto hard scatter events using PYTHIA. Simulated events are weighted to match the distribution of the mean number of interactions per bunch crossing observed in data.

The data sample was collected with a single-muon trigger ($p_T > 18$ GeV) or a single-electron trigger ($E_T > 20$ or 22 GeV, depending on the instantaneous luminosity). At least one signal lepton is required to have triggered the event and have $p_T(E_T)$ above 20 GeV (25 GeV) for muons (electrons). Events recorded during normal running conditions are analyzed if at least one of the reconstructed primary vertices has more than four tracks associated to it. Events containing jets with $|\eta| < 4.9$ and failing the quality criteria described in Ref. [29] are rejected to suppress both collisional and noncollisional background. Selected events must contain exactly three signal leptons. As leptonic decays of $\tilde{\chi}_j^0$ yield same-flavor opposite-sign (SFOS) lepton pairs, the presence of at least one such pair is required. The invariant mass of any SFOS lepton pair must be above 20 GeV to suppress background from low mass resonances and the missing transverse momentum must satisfy $E_T^{\text{miss}} > 50$ GeV.

Two signal regions are then defined: a “ Z -depleted” region (SR1), with no SFOS pairs having invariant mass within 10 GeV of the nominal Z -boson mass; and a “ Z -enriched” one (SR2), where at least one SFOS pair has an invariant mass within 10 GeV of the Z -boson mass. Events in SR1 are further required to contain no b -tagged jets to suppress contributions from b -jet-rich backgrounds, where a fake lepton could originate from a heavy-flavor decay. The SR1 and SR2 selections target SUSY events with intermediate slepton or on-mass-shell Z -boson decays, respectively.

Several SM processes contribute to the background in SR1 and SR2. A background process is considered “irreducible” if it leads to events with three real and isolated leptons, referred to as “real” leptons below. These include diboson ($WZ^{(*)}$ and $ZZ^{(*)}$) and $t\bar{t}W/Z^{(*)}$ production, where the gauge boson may be produced off-mass-shell. Their contribution is determined using the corresponding MC

samples, for which lepton and jet selection efficiencies are corrected to account for differences with respect to data. A “reducible” process has at least one “fake” object, that is either a lepton from a semileptonic decay of a heavy-flavor quark or an electron from an isolated photon conversion. The contribution from misidentified light-flavor quarks is negligible. The reducible background includes single- and pair-production of top-quark and $WW^{(*)}$ or $W^{(*)}/Z^{(*)}$ produced in association with jets or photons. The dominant component is the production of top quarks, with a contribution of 1% or less from $Z^{(*)} + \text{jets}$ production. The reducible background is estimated using a “matrix method” similar to that described in Ref. [50].

In this implementation of the matrix method, the signal lepton with the highest p_T or E_T is taken to be real, which is a valid assumption in 99% of the cases, based on MC studies. The number of observed events with one or two fakes is then extracted from a system of linear equations linking the number of events with two additional signal or tagged candidates to the number of events with two additional candidates that are either real or fake. The coefficients of the linear equations are functions of the real lepton identification efficiencies and of the fake object misidentification probabilities. The identification efficiency is measured in data using lepton candidates from $Z \rightarrow \ell\ell$ decays.

Misidentification probabilities for each fake type (heavy-flavor, conversion) and for each reducible background process are obtained using simulated events with one signal and two tagged leptons. These misidentification probabilities are then corrected using the ratio (fake scale factor) of the misidentification probability in data and that in MC simulation obtained in dedicated control samples. For heavy-flavor fakes, the correction factor is measured in $b\bar{b}$ events, while for conversion fakes it is determined in a sample of photons radiated from a muon in $Z \rightarrow \mu\mu$ decays. A weighted average misidentification probability is then calculated by weighting the corrected type- and process-dependent misidentification probabilities according to the process cross section.

An additional source of background is due to events with two signal leptons and one virtual photon converting into two muons, one with p_T above 10 GeV. The contribution from events in which both muons from the virtual photons have p_T above 10 GeV is negligible due to the requirement on the dilepton pair invariant mass. For events with only one muon above threshold, an upper limit of 0.5 ± 0.5 in SR1 and of 0.7 ± 0.7 in SR2 is obtained from data as follows. The number of observed events with exactly two signal leptons and $E_T^{\text{miss}} > 50$ GeV is rescaled by the probability that any of the signal leptons could have radiated the converted photon. This probability is measured in events with $E_T^{\text{miss}} < 50$ GeV as the ratio of number of events with three signal muons with trilepton invariant mass within 10 GeV of the nominal Z boson mass to the

number of events with two signal muons having the dilepton mass in the same mass window.

The matrix method has been tested using MC events and shown to be accurate within 2%. The background predictions have been validated in a region dominated by $Z^{(*)} + \text{jets}$ production (VR1: three signal leptons, $30 < E_T^{\text{miss}} < 50$ GeV) and in one dominated by top pair-production (VR2: three signal leptons, SFOS lepton pairs vetoed, $E_T^{\text{miss}} > 50$ GeV). The data and predictions are in agreement within the quoted statistical and systematic uncertainties as shown in Table I.

Several sources of systematic uncertainty are considered in the signal regions. The systematic uncertainties affecting the MC based estimates (irreducible background yield, misidentification probabilities, signal yield) include the theoretical cross-section uncertainty due to scale and PDFs, the acceptance uncertainty due to PDFs, jet energy scale, jet energy resolution, lepton energy scale, lepton energy resolution, lepton efficiency, b -tagging efficiency, event quality selection, and the uncertainty on the luminosity. In SR1, the total uncertainty on the irreducible background is 17%. This includes the uncertainty on the acceptance due to PDFs (14%), that on the theoretical cross section due to scale and PDFs (7%), and that from the limited number of simulated events (10%), while all the remaining uncertainties on the irreducible background in this signal region range between 0.5%–5%. The total uncertainty on the reducible background is 29%. This includes an uncertainty on the object misidentification probability of 10%–30% from the sources listed above. The uncertainty from the dependence of the misidentification probability on E_T^{miss} (0.4%–17%) and the uncertainty on the fake scale factors (10%–50%) are also included in the total, together with the uncertainty from the limited number of data events with three tagged leptons, of which at least one is a signal lepton. The total uncertainties on the signal cross-section range between 10%–15%. These include uncertainties due to the renormalization and factorization scale, α_s , and PDFs. The maximum uncertainty obtained from either the CTEQ6.6 or the MSTW [51] PDF set is used. In SR2, the values of systematic uncertainties are similar to those obtained in SR1. The only exceptions

TABLE I. Expected numbers of events from SM backgrounds (Bkg.) and observed numbers of events in data, for 2.06 fb^{-1} , in control regions VR1 and VR2, and in signal regions SR1 and SR2. Both statistical and systematic uncertainties are included.

Selection	VR1	VR2	SR1	SR2
$t\bar{t}W^{(*)}/Z^{(*)}$	1.4 ± 1.1	0.7 ± 0.6	0.4 ± 0.3	2.7 ± 2.1
$ZZ^{(*)}$	6.7 ± 1.5	0.03 ± 0.04	0.7 ± 0.2	3.4 ± 0.8
$WZ^{(*)}$	61 ± 11	0.4 ± 0.2	11 ± 2	58 ± 11
Reducible Bkg.	56 ± 35	14 ± 9	14 ± 4	7.5 ± 3.9
Total Bkg.	125 ± 37	15 ± 9	26 ± 5	72 ± 12
Data	122	12	32	95

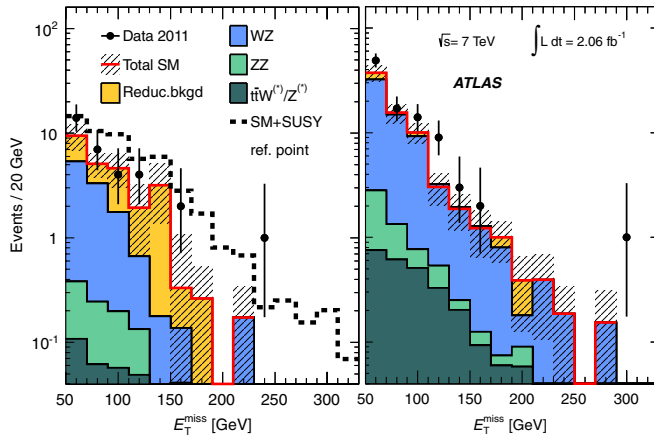


FIG. 1 (color online). E_T^{miss} distributions for events in signal regions SR1 (left) and SR2 (right). The error band includes both statistical and systematic uncertainty, while the errors on the data points are statistical only. The SUSY reference point used in SR1 is described in the text.

are the uncertainty from the limited number of simulated events (4%) and the uncertainty on the reducible background (52%). In all of the above, the value used for the uncertainty on the luminosity is 3.7%.

The numbers of observed events and the prediction for SM backgrounds in SR1 and SR2 are reported in Table I. The probability that the background fluctuates to the observed number of events or higher is calculated in the frequentist approach and found to be 19% in SR1 and 6% in SR2. The distributions of the E_T^{miss} in the two signal regions are presented in Fig. 1. The yield in SR1 for one of the simplified model scenarios ($m_{\tilde{\chi}_1^\pm}, m_{\tilde{\chi}_2^0}, m_{\tilde{\ell}_L}, m_{\tilde{\chi}_1^0} = 250, 250, 175, 100$ GeV) is also shown for illustration purposes.

No significant excess of events is found in either signal region. Upper limits on the visible production cross-section of 9.9 fb in SR1 and 23.8 fb in SR2 are placed at 95% confidence level (C.L.) with the modified frequentist C.L._s prescription [52]. No corrections for the effects of experimental resolution, acceptance and efficiency are applied. All systematic uncertainties and their correlations are taken into account via nuisance parameters. The corresponding expected limits are 7.1 and 14.1 fb, respectively. In SR2, the observed limit on the visible cross-section is less stringent than the expected limit because of the upwards fluctuation in the number of events in data with respect to the expected background. SR1 provides better sensitivity in the parameter space considered and the limits are interpreted in simplified models and pMSSM scenarios with $M_1 = 100$ GeV and $\tan\beta = 6$ (Fig. 2). The chosen M_1 value leads to a sizable mass splitting between $\tilde{\chi}_1^\pm$ and $\tilde{\chi}_1^0$ and therefore to a large acceptance. The value of $\tan\beta$ does not have a significant impact on $\sigma(pp \rightarrow \tilde{\chi}_i^\pm \tilde{\chi}_j^0) \times BR(\tilde{\chi}_i^\pm \tilde{\chi}_j^0 \rightarrow \ell\ell\ell\tilde{\chi}_1^0)$, which varies by $\sim 10\%$ if $\tan\beta$ is raised to 10.

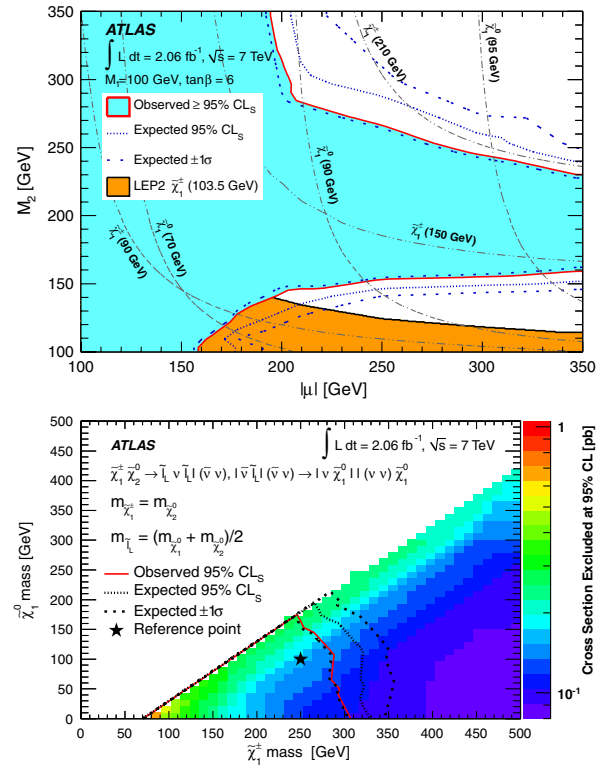


FIG. 2 (color online). Observed and expected 95% C.L. limit contours for chargino and neutralino production in the pMSSM (upper) and simplified model (lower) scenarios. For the simplified models, the 95% C.L. upper limit on the production cross-section is also shown. Interpolation is used to account for the discreteness of the signal grids.

In the simplified models, degenerate $\tilde{\chi}_1^\pm$ and $\tilde{\chi}_2^0$ masses up to 300 GeV are excluded for large mass differences from the $\tilde{\chi}_1^0$. Care has to be taken when interpreting the simplified model limit in the context of a pMSSM scenario, where the mass of the sneutrino is lighter than the mass of the left-handed slepton, leading to higher lepton momenta from chargino decays and to a change in the branching ratios of the $\tilde{\chi}_2^0$.

In summary, results from the first ATLAS search for the weak production of charginos and neutralinos decaying to a final state with three leptons (electrons or muons) and missing transverse momentum are reported. The analysis is based on 2.06 fb^{-1} of proton-proton collision data delivered by the LHC at $\sqrt{s} = 7$ TeV. No significant excess of events is found in data, where upwards fluctuations of less than 2-sigma are observed. The null result is interpreted in pMSSM and in simplified models. For the simplified models with intermediate sleptons considered in this paper, degenerate lightest chargino and next-to-lightest neutralino masses are excluded up to 300 GeV for mass differences to the lightest neutralino up to 300 GeV.

We thank CERN for the very successful operation of the LHC, as well as the support staff from our institutions without whom ATLAS could not be operated efficiently.

We acknowledge the support of ANPCyT, Argentina; YerPhI, Armenia; ARC, Australia; BMWF, Austria; ANAS, Azerbaijan; SSTC, Belarus; CNPq and FAPESP, Brazil; NSERC, NRC and CFI, Canada; CERN; CONICYT, Chile; CAS, MOST and NSFC, China; COLCIENCIAS, Colombia; MSMT CR, MPO CR and VSC CR, Czech Republic; DNRF, DNSRC and Lundbeck Foundation, Denmark; EPLANET and ERC, European Union; IN2P3-CNRS, CEA-DSM/IRFU, France; GNAS, Georgia; BMBF, DFG, HGF, MPG, and AvH Foundation, Germany; GSRT, Greece; ISF, MINERVA, GIF, DIP, and Benoziyo Center, Israel; INFN, Italy; MEXT and JSPS, Japan; CNRST, Morocco; FOM and NWO, Netherlands; RCN, Norway; MNiSW, Poland; GRICES and FCT, Portugal; MERYS (MECTS), Romania; MES of Russia and ROSATOM, Russian Federation; JINR; MSTD, Serbia; MSSR, Slovakia; ARRS and MVZT, Slovenia; DST/NRF, South Africa; MICINN, Spain; SRC and Wallenberg Foundation, Sweden; SER, SNSF and Cantons of Bern and Geneva, Switzerland; NSC, Taiwan; TAEK, Turkey; STFC, the Royal Society and Leverhulme Trust, United Kingdom; DOE and NSF, United States of America. The crucial computing support from all WLCG partners is acknowledged gratefully, in particular, from CERN and the ATLAS Tier-1 facilities at TRIUMF (Canada), NDGF (Denmark, Norway, Sweden), CC-IN2P3 (France), KIT/GridKA (Germany), INFN-CNAF (Italy), NL-T1 (Netherlands), PIC (Spain), ASGC (Taiwan), RAL (UK), and BNL (USA) and in the Tier-2 facilities worldwide.

-
- [1] H. Miyazawa, *Prog. Theor. Phys.* **36**, 1266 (1966)
 - [2] P. Ramond, *Phys. Rev. D* **3**, 2415 (1971).
 - [3] Yu. A. Gol'fand and E. P. Likhtman, *JETP Lett.* **13**, 323 (1971).
 - [4] A. Neveu and J. H. Schwarz, *Nucl. Phys.* **B31**, 86 (1971).
 - [5] A. Neveu and J. H. Schwarz, *Phys. Rev. D* **4**, 1109 (1971).
 - [6] J. Gervais and B. Sakita, *Nucl. Phys.* **B34**, 632 (1971).
 - [7] D. Volkov and V. Akulov, *Phys. Lett. B* **46**, 109 (1973).
 - [8] J. Wess and B. Zumino, *Phys. Lett. B* **49**, 52 (1974).
 - [9] J. Wess and B. Zumino, *Nucl. Phys.* **B70**, 39 (1974).
 - [10] E. Witten, *Nucl. Phys.* **B188**, 513 (1981).
 - [11] N. Sakai, *Z. Phys. C* **11**, 153 (1981).
 - [12] S. Dimopoulos and H. Georgi, *Nucl. Phys.* **B193**, 150 (1981).
 - [13] P. Fayet, *Phys. Lett. B* **64**, 159 (1976).
 - [14] P. Fayet, *Phys. Lett. B* **69**, 489 (1977).
 - [15] G. R. Farrar and P. Fayet, *Phys. Lett. B* **76**, 575 (1978).
 - [16] P. Fayet, *Phys. Lett. B* **84**, 416 (1979).
 - [17] S. Dimopoulos and H. Georgi, *Nucl. Phys.* **B193**, 150 (1981).
 - [18] K. L. Chan, U. Chattopadhyay, and P. Nath, *Phys. Rev. D* **58**, 096004 (1998).
 - [19] LEPSUSYWG, ALEPH, DELPHI, L3, OPAL Collaborations, Reports No. LEPSUSYWG/01-03.1 and No. 04-01.1, 2001.
 - [20] V. Abazov *et al.* (D0 Collaboration), *Phys. Lett. B* **680**, 34 (2009).
 - [21] T. Aaltonen *et al.* (CDF Collaboration), *Phys. Rev. Lett.* **101**, 251801 (2008).
 - [22] ATLAS Collaboration, *Phys. Lett. B* **709**, 137 (2012).
 - [23] A. Djouadi, J. L. Kneur, and G. Moultaka, *Comput. Phys. Commun.* **176**, 426 (2007).
 - [24] J. Alwall, P. C. Schuster, and N. Toro, *Phys. Rev. D* **79**, 075020 (2009).
 - [25] ATLAS Collaboration, *JINST* **3**, S08003 (2008).
 - [26] ATLAS uses a right-handed coordinate system with its origin at the nominal interaction point (IP) in the center of the detector and the z -axis along the beam pipe. The x -axis points from the IP to the center of the LHC ring, and the y -axis points upward. Cylindrical coordinates (R, ϕ) are used in the transverse plane, ϕ being the azimuthal angle around the beam pipe. The pseudorapidity is defined in terms of the polar angle θ as $\eta = -\ln \tan(\theta/2)$.
 - [27] ATLAS Collaboration, *J. High Energy Phys.* **12** (2010) 60.
 - [28] M. Cacciari, G. P. Salam, and G. Soyez, *J. High Energy Phys.* **04** (2008) 063.
 - [29] ATLAS Collaboration, [arXiv:1112.6426](https://arxiv.org/abs/1112.6426) [Eur. Phys. J. C (to be published)].
 - [30] ATLAS Collaboration, Report No. ATLAS-CONF-2011-102, <https://cdsweb.cern.ch/record/1369219>.
 - [31] ATLAS Collaboration, *Eur. Phys. J. C* **72**, 1844 (2012).
 - [32] G. Corcella, I. G. Knowles, G. Marchesini, S. Moretti, K. Odagiri, P. Richardson, M. H. Seymour, and B. R. Webber, *J. High Energy Phys.* **01** (2001) 010.
 - [33] J. Alwall, M. Herquet, F. Maltoni, O. Mattelaer, and T. Stelzer, *J. High Energy Phys.* **06** (2011) 128.
 - [34] S. Frixione and B. R. Webber, *J. High Energy Phys.* **06** (2002) 029.
 - [35] M. Mangano, F. Piccinini, A. D. Polosa, M. Moretti and R. Pittau, *J. High Energy Phys.* **07** (2003) 001.
 - [36] J. M. Campbell and R. K. Ellis, *Phys. Rev. D* **60**, 113006 (1999).
 - [37] J. M. Campbell, R. K. Ellis, and C. Williams, *J. High Energy Phys.* **07** (2011) 018.
 - [38] M. Aliev, H. Lacker, U. Langenfeld, S. Moch, P. Uwer, and M. Wiedermann, *Comput. Phys. Commun.* **182**, 1034 (2011).
 - [39] A. Kardos, C. Papadopoulos, and Z. Trócsányi, [arXiv:1111.0610](https://arxiv.org/abs/1111.0610).
 - [40] K. Melnikov and F. Petriello, *Phys. Rev. D* **74**, 114017 (2006).
 - [41] C. Anastasiou, L. Dixon, K. Melnikov, and F. Petriello, *Phys. Rev. D* **69**, 094008 (2004).
 - [42] A. Sherstnev and R. Thorne, *Eur. Phys. J. C* **55**, 553 (2008).
 - [43] J. Pumplin, D. R. Stump, J. Huston, H.-L. Lai, P. Nadolsky, and W.-K. Tung, *J. High Energy Phys.* **07** (2002) 012.
 - [44] P. M. Nadolsky, H.-L. Lai, Q.-H. Cao, J. Huston, J. Pumplin, D. Stump, W.-K. Tung, and C.-P. Yuan, *Phys. Rev. D* **78**, 013004 (2008).
 - [45] M. Bahr *et al.*, *Eur. Phys. J. C* **58**, 639 (2008).
 - [46] W. Beenakker, R. Hopker, M. Spira, and P. M. Zerwas, *Nucl. Phys.* **B492**, 51 (1997).
 - [47] T. Sjostrand, S. Mrenna, and P. Skands, *J. High Energy Phys.* **05** (2006) 026.

- [48] GEANT4 Collaboration, *Nucl. Instrum. Methods Phys. Res., Sect. A* **506**, 250 (2003).
- [49] ATLAS Collaboration, *Eur. Phys. J. C* **70**, 823 (2010).
- [50] ATLAS Collaboration, *Eur. Phys. J. C* **71**, 1577 (2011).
- [51] A. Martin, W. Stirling, R. S. Thorne, and G. Watt, *Eur. Phys. J. C* **63**, 189 (2009).
- [52] A. L. Read, *J. Phys. G* **28**, 2693 (2002).
-
- G. Aad,⁴⁷ B. Abbott,¹¹⁰ J. Abdallah,¹¹ S. Abdel Khalek,¹¹⁴ A. A. Abdelalim,⁴⁸ O. Abdinov,¹⁰ B. Abi,¹¹¹ M. Abolins,⁸⁷ O. S. AbouZeid,¹⁵⁷ H. Abramowicz,¹⁵² H. Abreu,¹³⁵ E. Acerbi,^{88a,88b} B. S. Acharya,^{163a,163b} L. Adamczyk,³⁷ D. L. Adams,²⁴ T. N. Addy,⁵⁵ J. Adelman,¹⁷⁴ S. Adomeit,⁹⁷ P. Adragna,⁷⁴ T. Adye,¹²⁸ S. Aefsky,²² J. A. Aguilar-Saavedra,^{123b,b} M. Aharrouche,⁸⁰ S. P. Ahlen,²¹ F. Ahles,⁴⁷ A. Ahmad,¹⁴⁷ M. Ahsan,⁴⁰ G. Aielli,^{132a,132b} T. Akdogan,^{18a} T. P. A. Åkesson,⁷⁸ G. Akimoto,¹⁵⁴ A. V. Akimov,⁹³ A. Akiyama,⁶⁵ M. S. Alam,¹ M. A. Alam,⁷⁵ J. Albert,¹⁶⁸ S. Albrand,⁵⁴ M. Aleksa,²⁹ I. N. Aleksandrov,⁶³ F. Alessandria,^{88a} C. Alexa,^{25a} G. Alexander,¹⁵² G. Alexandre,⁴⁸ T. Alexopoulos,⁹ M. Alhroob,^{163a,163c} M. Aliev,¹⁵ G. Alimonti,^{88a} J. Alison,¹¹⁹ B. M. M. Allbrooke,¹⁷ P. P. Allport,⁷² S. E. Allwood-Spiers,⁵² J. Almond,⁸¹ A. Aloisio,^{101a,101b} R. Alon,¹⁷⁰ A. Alonso,⁷⁸ B. Alvarez Gonzalez,⁸⁷ M. G. Alviggi,^{101a,101b} K. Amako,⁶⁴ C. Amelung,²² V. V. Ammosov,¹²⁷ A. Amorim,^{123a,c} G. Amorós,¹⁶⁶ N. Amram,¹⁵² C. Anastopoulos,²⁹ L. S. Ancu,¹⁶ N. Andari,¹¹⁴ T. Andeen,³⁴ C. F. Anders,²⁰ G. Anders,^{57a} K. J. Anderson,³⁰ A. Andreazza,^{88a,88b} V. Andrei,^{57a} X. S. Anduaga,⁶⁹ A. Angerami,³⁴ F. Anghinolfi,²⁹ A. Anisenkov,¹⁰⁶ N. Anjos,^{123a} A. Annovi,⁴⁶ A. Antonaki,⁸ M. Antonelli,⁴⁶ A. Antonov,⁹⁵ J. Antos,^{143b} F. Anulli,^{131a} S. Aoun,⁸² L. Aperio Bella,⁴ R. Apolle,^{117,d} G. Arabidze,⁸⁷ I. Aracena,¹⁴² Y. Arai,⁶⁴ A. T. H. Arce,⁴⁴ S. Arfaoui,¹⁴⁷ J-F. Arguin,¹⁴ E. Arik,^{18a,a} M. Arik,^{18a} A. J. Armbruster,⁸⁶ O. Arnaez,⁸⁰ V. Arnal,⁷⁹ C. Arnault,¹¹⁴ A. Artamonov,⁹⁴ G. Artoni,^{131a,131b} D. Arutinov,²⁰ S. Asai,¹⁵⁴ R. Asfandiyarov,¹⁷¹ S. Ask,²⁷ B. Åsman,^{145a,145b} L. Asquith,⁵ K. Assamagan,²⁴ A. Astbury,¹⁶⁸ B. Aubert,⁴ E. Auge,¹¹⁴ K. Augsten,¹²⁶ M. Auresseau,^{144a} G. Avolio,¹⁶² R. Avramidou,⁹ D. Axen,¹⁶⁷ G. Azuelos,^{92,e} Y. Azuma,¹⁵⁴ M. A. Baak,²⁹ G. Baccaglioni,^{88a} C. Bacci,^{133a,133b} A. M. Bach,¹⁴ H. Bachacou,¹³⁵ K. Bachas,²⁹ M. Backes,⁴⁸ M. Backhaus,²⁰ E. Badescu,^{25a} P. Bagnaia,^{131a,131b} S. Bahinipati,² Y. Bai,^{32a} D. C. Bailey,¹⁵⁷ T. Bain,¹⁵⁷ J. T. Baines,¹²⁸ O. K. Baker,¹⁷⁴ M. D. Baker,²⁴ S. Baker,⁷⁶ E. Banas,³⁸ P. Banerjee,⁹² Sw. Banerjee,¹⁷¹ D. Banfi,²⁹ A. Bangert,¹⁴⁹ V. Bansal,¹⁶⁸ H. S. Bansil,¹⁷ L. Barak,¹⁷⁰ S. P. Baranov,⁹³ A. Barbaro Galtieri,¹⁴ T. Barber,⁴⁷ E. L. Barberio,⁸⁵ D. Barberis,^{49a,49b} M. Barbero,²⁰ D. Y. Bardin,⁶³ T. Barillari,⁹⁸ M. Barisonzi,¹⁷³ T. Barklow,¹⁴² N. Barlow,²⁷ B. M. Barnett,¹²⁸ R. M. Barnett,¹⁴ A. Baroncelli,^{133a} G. Barone,⁴⁸ A. J. Barr,¹¹⁷ F. Barreiro,⁷⁹ J. Barreiro Guimarães da Costa,⁵⁶ P. Barrillon,¹¹⁴ R. Bartoldus,¹⁴² A. E. Barton,⁷⁰ V. Bartsch,¹⁴⁸ R. L. Bates,⁵² L. Batkova,^{143a} J. R. Batley,²⁷ A. Battaglia,¹⁶ M. Battistin,²⁹ F. Bauer,¹³⁵ H. S. Bawa,^{142,f} S. Beale,⁹⁷ T. Beau,⁷⁷ P. H. Beauchemin,¹⁶⁰ R. Beccherle,^{49a} P. Bechtel,²⁰ H. P. Beck,¹⁶ S. Becker,⁹⁷ M. Beckingham,¹³⁷ K. H. Becks,¹⁷³ A. J. Beddall,^{18c} A. Beddall,^{18c} S. Bedikian,¹⁷⁴ V. A. Bednyakov,⁶³ C. P. Bee,⁸² M. Begel,²⁴ S. Behar Harpaz,¹⁵¹ P. K. Behera,⁶¹ M. Beimforde,⁹⁸ C. Belanger-Champagne,⁸⁴ P. J. Bell,⁴⁸ W. H. Bell,⁴⁸ G. Bella,¹⁵² L. Bellagamba,^{19a} F. Bellina,²⁹ M. Bellomo,²⁹ A. Belloni,⁵⁶ O. Beloborodova,^{106,g} K. Belotskiy,⁹⁵ O. Beltramello,²⁹ O. Benary,¹⁵² D. Bencheikroun,^{134a} K. Bendtz,^{145a,145b} N. Benekos,¹⁶⁴ Y. Benhammou,¹⁵² E. Benhar Nocchioli,⁴⁸ J. A. Benitez Garcia,^{158b} D. P. Benjamin,⁴⁴ M. Benoit,¹¹⁴ J. R. Bensinger,²² K. Benslama,¹²⁹ S. Bentvelsen,¹⁰⁴ D. Berge,²⁹ E. Bergeas Kuutmann,⁴¹ N. Berger,⁴ F. Berghaus,¹⁶⁸ E. Berglund,¹⁰⁴ J. Beringer,¹⁴ P. Bernat,⁷⁶ R. Bernhard,⁴⁷ C. Bernius,²⁴ T. Berry,⁷⁵ C. Bertella,⁸² A. Bertin,^{19a,19b} F. Bertolucci,^{121a,121b} M. I. Besana,^{88a,88b} N. Besson,¹³⁵ S. Bethke,⁹⁸ W. Bhimji,⁴⁵ R. M. Bianchi,²⁹ M. Bianco,^{71a,71b} O. Biebel,⁹⁷ S. P. Bieniek,⁷⁶ K. Bierwagen,⁵³ J. Biesiada,¹⁴ M. Biglietti,^{133a} H. Bilokon,⁴⁶ M. Bindi,^{19a,19b} S. Binet,¹¹⁴ A. Bingul,^{18c} C. Bini,^{131a,131b} C. Biscarat,¹⁷⁶ U. Bitenc,⁴⁷ K. M. Black,²¹ R. E. Blair,⁵ J.-B. Blanchard,¹³⁵ G. Blanchot,²⁹ T. Blazek,^{143a} C. Blocker,²² J. Blocki,³⁸ A. Blondel,⁴⁸ W. Blum,⁸⁰ U. Blumenschein,⁵³ G. J. Bobbink,¹⁰⁴ V. B. Bobrovnikov,¹⁰⁶ S. S. Bocchetta,⁷⁸ A. Bocci,⁴⁴ C. R. Boddy,¹¹⁷ M. Boehler,⁴¹ J. Boek,¹⁷³ N. Boelaert,³⁵ J. A. Bogaerts,²⁹ A. Bogdanchikov,¹⁰⁶ A. Bogouch,^{89,a} C. Bohm,^{145a} J. Bohm,¹²⁴ V. Boisvert,⁷⁵ T. Bold,³⁷ V. Boldea,^{25a} N. M. Bolnet,¹³⁵ M. Bomben,⁷⁷ M. Bona,⁷⁴ M. Bondioli,¹⁶² M. Boonekamp,¹³⁵ C. N. Booth,¹³⁸ S. Bordonì,⁷⁷ C. Borer,¹⁶ A. Borisov,¹²⁷ G. Borissov,⁷⁰ I. Borjanovic,^{12a} M. Borri,⁸¹ S. Borroni,⁸⁶ V. Bortolotto,^{133a,133b} K. Bos,¹⁰⁴ D. Boscherini,^{19a} M. Bosman,¹¹ H. Boterenbrood,¹⁰⁴ D. Botterill,¹²⁸ J. Bouchami,⁹² J. Boudreau,¹²² E. V. Bouhova-Thacker,⁷⁰ D. Boumediene,³³ C. Bourdarios,¹¹⁴ N. Bousson,⁸² A. Boveia,³⁰ J. Boyd,²⁹ I. R. Boyko,⁶³ N. I. Bozhko,¹²⁷ I. Bozovic-Jelisavcic,^{12b} J. Bracinik,¹⁷ P. Branchini,^{133a} A. Brandt,⁷ G. Brandt,¹¹⁷ O. Brandt,⁵³ U. Bratzler,¹⁵⁵ B. Brau,⁸³ J. E. Brau,¹¹³ H. M. Braun,¹⁷³ B. Brelier,¹⁵⁷ J. Bremer,²⁹ K. Brendlinger,¹¹⁹ R. Brenner,¹⁶⁵ S. Bressler,¹⁷⁰ D. Britton,⁵² F. M. Brochu,²⁷ I. Brock,²⁰ R. Brock,⁸⁷ E. Brodet,¹⁵² F. Broggi,^{88a}

- C. Bromberg,⁸⁷ J. Bronner,⁹⁸ G. Brooijmans,³⁴ W. K. Brooks,^{31b} G. Brown,⁸¹ H. Brown,⁷
P. A. Bruckman de Renstrom,³⁸ D. Bruncko,^{143b} R. Bruneliere,⁴⁷ S. Brunet,⁵⁹ A. Bruni,^{19a} G. Bruni,^{19a}
M. Bruschi,^{19a} T. Buanes,¹³ Q. Buat,⁵⁴ F. Bucci,⁴⁸ J. Buchanan,¹¹⁷ P. Buchholz,¹⁴⁰ R. M. Buckingham,¹¹⁷
A. G. Buckley,⁴⁵ S. I. Buda,^{25a} I. A. Budagov,⁶³ B. Budick,¹⁰⁷ V. Büscher,⁸⁰ L. Bugge,¹¹⁶ O. Bulekov,⁹⁵
A. C. Bundock,⁷² M. Bunse,⁴² T. Buran,¹¹⁶ H. Burckhart,²⁹ S. Burdin,⁷² T. Burgess,¹³ S. Burke,¹²⁸ E. Busato,³³
P. Bussey,⁵² C. P. Buszello,¹⁶⁵ B. Butler,¹⁴² J. M. Butler,²¹ C. M. Buttar,⁵² J. M. Butterworth,⁷⁶ W. Buttinger,²⁷
S. Cabrera Urbán,¹⁶⁶ D. Caforio,^{19a,19b} O. Cakir,^{3a} P. Calafiura,¹⁴ G. Calderini,⁷⁷ P. Calfayan,⁹⁷ R. Calkins,¹⁰⁵
L. P. Caloba,^{23a} R. Caloi,^{131a,131b} D. Calvet,³³ S. Calvet,³³ R. Camacho Toro,³³ P. Camarri,^{132a,132b} D. Cameron,¹¹⁶
L. M. Caminada,¹⁴ S. Campana,²⁹ M. Campanelli,⁷⁶ V. Canale,^{101a,101b} F. Canelli,^{30,h} A. Canepa,^{158a} J. Cantero,⁷⁹
L. Capasso,^{101a,101b} M. D. M. Capeans Garrido,²⁹ I. Caprini,^{25a} M. Caprini,^{25a} D. Capriotti,⁹⁸ M. Capua,^{36a,36b}
R. Caputo,⁸⁰ R. Cardarelli,^{132a} T. Carli,²⁹ G. Carlino,^{101a} L. Carminati,^{88a,88b} B. Caron,⁸⁴ S. Caron,¹⁰³ E. Carquin,^{31b}
G. D. Carrillo Montoya,¹⁷¹ A. A. Carter,⁷⁴ J. R. Carter,²⁷ J. Carvalho,^{123a,i} D. Casadei,¹⁰⁷ M. P. Casado,¹¹
M. Cascella,^{121a,121b} C. Caso,^{49a,49b,a} A. M. Castaneda Hernandez,¹⁷¹ E. Castaneda-Miranda,¹⁷¹
V. Castillo Gimenez,¹⁶⁶ N. F. Castro,^{123a} G. Cataldi,^{71a} P. Catastini,⁵⁶ A. Catinaccio,²⁹ J. R. Catmore,²⁹ A. Cattai,²⁹
G. Cattani,^{132a,132b} S. Caughron,⁸⁷ D. Cauz,^{163a,163c} P. Cavalleri,⁷⁷ D. Cavalli,^{88a} M. Cavalli-Sforza,¹¹
V. Cavasinni,^{121a,121b} F. Ceradini,^{133a,133b} A. S. Cerqueira,^{23b} A. Cerri,²⁹ L. Cerrito,⁷⁴ F. Cerutti,⁴⁶ S. A. Cetin,^{18b}
A. Chafaq,^{134a} D. Chakraborty,¹⁰⁵ I. Chalupkova,¹²⁵ K. Chan,² B. Chapleau,⁸⁴ J. D. Chapman,²⁷ J. W. Chapman,⁸⁶
E. Chareyre,⁷⁷ D. G. Charlton,¹⁷ V. Chavda,⁸¹ C. A. Chavez Barajas,²⁹ S. Cheatham,⁸⁴ S. Chekanov,⁵
S. V. Chekulaev,^{158a} G. A. Chelkov,⁶³ M. A. Chelstowska,¹⁰³ C. Chen,⁶² H. Chen,²⁴ S. Chen,^{32c} X. Chen,¹⁷¹
A. Cheplakov,⁶³ R. Cherkaoui El Moursli,^{134e} V. Chernyatin,²⁴ E. Cheu,⁶ S. L. Cheung,¹⁵⁷ L. Chevalier,¹³⁵
G. Chiefari,^{101a,101b} L. Chikovani,^{50a} J. T. Childers,²⁹ A. Chilingarov,⁷⁰ G. Chiodini,^{71a} A. S. Chisholm,¹⁷
R. T. Chislett,⁷⁶ M. V. Chizhov,⁶³ G. Choudalakis,³⁰ S. Chouridou,¹³⁶ I. A. Christidi,⁷⁶ A. Christov,⁴⁷
D. Chromek-Burckhart,²⁹ M. L. Chu,¹⁵⁰ J. Chudoba,¹²⁴ G. Ciapetti,^{131a,131b} A. K. Ciftci,^{3a} R. Ciftci,^{3a} D. Cinca,³³
V. Cindro,⁷³ C. Ciocca,^{19a} A. Ciocio,¹⁴ M. Cirilli,⁸⁶ M. Citterio,^{88a} M. Ciubancan,^{25a} A. Clark,⁴⁸ P. J. Clark,⁴⁵
W. Cleland,¹²² J. C. Clemens,⁸² B. Clement,⁵⁴ C. Clement,^{145a,145b} Y. Coadou,⁸² M. Cobal,^{163a,163c} A. Cocco,¹³⁷
J. Cochran,⁶² P. Coe,¹¹⁷ J. G. Cogan,¹⁴² J. Coggeshall,¹⁶⁴ E. Cogneras,¹⁷⁶ J. Colas,⁴ A. P. Colijn,¹⁰⁴ N. J. Collins,¹⁷
C. Collins-Tooth,⁵² J. Collot,⁵⁴ G. Colon,⁸³ P. Conde Muiño,^{123a} E. Coniavitis,¹¹⁷ M. C. Conidi,¹¹
S. M. Consonni,^{88a,88b} V. Consorti,⁴⁷ S. Constantinescu,^{25a} C. Conta,^{118a,118b} G. Conti,⁵⁶ F. Conventi,^{101a,j}
M. Cooke,¹⁴ B. D. Cooper,⁷⁶ A. M. Cooper-Sarkar,¹¹⁷ K. Copic,¹⁴ T. Cornelissen,¹⁷³ M. Corradi,^{19a} F. Corriveau,^{84,k}
A. Cortes-Gonzalez,¹⁶⁴ G. Cortiana,⁹⁸ G. Costa,^{88a} M. J. Costa,¹⁶⁶ D. Costanzo,¹³⁸ T. Costin,³⁰ D. Côté,²⁹
L. Courneyea,¹⁶⁸ G. Cowan,⁷⁵ C. Cowden,²⁷ B. E. Cox,⁸¹ K. Cranmer,¹⁰⁷ F. Crescioli,^{121a,121b} M. Cristinziani,²⁰
G. Crosetti,^{36a,36b} R. Crupi,^{71a,71b} S. Crépe-Renaudin,⁵⁴ C.-M. Cuciuc,^{25a} C. Cuenca Almenar,¹⁷⁴
T. Cuhadar Donszelmann,¹³⁸ M. Curatolo,⁴⁶ C. J. Curtis,¹⁷ C. Cuthbert,¹⁴⁹ P. Cwetanski,⁵⁹ H. Czirr,¹⁴⁰
P. Czodrowski,⁴³ Z. Czyżczula,¹⁷⁴ S. D'Auria,⁵² M. D'Onofrio,⁷² A. D'Orazio,^{131a,131b} C. Da Via,⁸¹ W. Dabrowski,³⁷
A. Dafinca,¹¹⁷ T. Dai,⁸⁶ C. Dallapiccola,⁸³ M. Dam,³⁵ M. Dameri,^{49a,49b} D. S. Damiani,¹³⁶ H. O. Danielsson,²⁹
V. Dao,⁴⁸ G. Darbo,^{49a} G. L. Darlea,^{25b} W. Davey,²⁰ T. Davidek,¹²⁵ N. Davidson,⁸⁵ R. Davidson,⁷⁰ E. Davies,^{117,d}
M. Davies,⁹² A. R. Davison,⁷⁶ Y. Davygora,^{57a} E. Dawe,¹⁴¹ I. Dawson,¹³⁸ R. K. Daya-Ishmukhametova,²² K. De,⁷
R. de Asmundis,^{101a} S. De Castro,^{19a,19b} S. De Cecco,⁷⁷ J. de Graat,⁹⁷ N. De Groot,¹⁰³ P. de Jong,¹⁰⁴
C. De La Taille,¹¹⁴ H. De la Torre,⁷⁹ F. De Lorenzi,⁶² B. De Lotto,^{163a,163c} L. de Mora,⁷⁰ L. De Nooij,¹⁰⁴
D. De Pedis,^{131a} A. De Salvo,^{131a} U. De Sanctis,^{163a,163c} A. De Santo,¹⁴⁸ J. B. De Vivie De Regie,¹¹⁴
G. De Zorzi,^{131a,131b} W. J. Dearnaley,⁷⁰ R. Debye,²⁴ C. Debenedetti,⁴⁵ B. Dechenaux,⁵⁴ D. V. Dedovich,⁶³
J. Degenhardt,¹¹⁹ C. Del Papa,^{163a,163c} J. Del Peso,⁷⁹ T. Del Prete,^{121a,121b} T. Delemontex,⁵⁴ M. Deliyergiyev,⁷³
A. Dell'Acqua,²⁹ L. Dell'Asta,²¹ M. Della Pietra,^{101a,j} D. della Volpe,^{101a,101b} M. Delmastro,⁴ P. A. Delsart,⁵⁴
C. Deluca,¹⁴⁷ S. Demers,¹⁷⁴ M. Demichev,⁶³ B. Demirköz,^{11,l} J. Deng,¹⁶² S. P. Denisov,¹²⁷ D. Derendarz,³⁸
J. E. Derkaoui,^{134d} F. Derue,⁷⁷ P. Dervan,⁷² K. Desch,²⁰ E. Devetak,¹⁴⁷ P. O. Deviveiros,¹⁰⁴ A. Dewhurst,¹²⁸
B. DeWilde,¹⁴⁷ S. Dhaliwal,¹⁵⁷ R. Dhullipudi,^{24,m} A. Di Ciaccio,^{132a,132b} L. Di Ciaccio,⁴ A. Di Girolamo,²⁹
B. Di Girolamo,²⁹ S. Di Luise,^{133a,133b} A. Di Mattia,¹⁷¹ B. Di Micco,²⁹ R. Di Nardo,⁴⁶ A. Di Simone,^{132a,132b}
R. Di Sipio,^{19a,19b} M. A. Diaz,^{31a} F. Diblen,^{18c} E. B. Diehl,⁸⁶ J. Dietrich,⁴¹ T. A. Dietzsch,^{57a} S. Diglio,⁸⁵
K. Dindar Yagci,³⁹ J. Dingfelder,²⁰ C. Dionisi,^{131a,131b} P. Dita,^{25a} S. Dita,^{25a} F. Dittus,²⁹ F. Djama,⁸² T. Djobava,^{50b}
M. A. B. do Vale,^{23c} A. Do Valle Wemans,^{123a} T. K. O. Doan,⁴ M. Dobbs,⁸⁴ R. Dobinson,^{29,a} D. Dobos,²⁹
E. Dobson,^{29,n} J. Dodd,³⁴ C. Doglioni,⁴⁸ T. Doherty,⁵² Y. Doi,^{64,a} J. Dolejsi,¹²⁵ I. Dolenc,⁷³ Z. Dolezal,¹²⁵

- B. A. Dolgoshein,^{95,a} T. Dohmae,¹⁵⁴ M. Donadelli,^{23d} M. Donega,¹¹⁹ J. Donini,³³ J. Dopke,²⁹ A. Doria,^{101a}
A. Dos Anjos,¹⁷¹ A. Dotti,^{121a,121b} M. T. Dova,⁶⁹ A. D. Doxiadis,¹⁰⁴ A. T. Doyle,⁵² M. Dris,⁹ J. Dubbert,⁹⁸ S. Dube,¹⁴
E. Duchovni,¹⁷⁰ G. Duckeck,⁹⁷ A. Dudarev,²⁹ F. Dudziak,⁶² M. Dührssen,²⁹ I. P. Duerdorth,⁸¹ L. Duflo,¹¹⁴
M-A. Dufour,⁸⁴ M. Dunford,²⁹ H. Duran Yildiz,^{3a} R. Duxfield,¹³⁸ M. Dwuznik,³⁷ F. Dydak,²⁹ M. Düren,⁵¹ J. Ebke,⁹⁷
S. Eckweiler,⁸⁰ K. Edmonds,⁸⁰ C. A. Edwards,⁷⁵ N. C. Edwards,⁵² W. Ehrenfeld,⁴¹ T. Eifert,¹⁴² G. Eigen,¹³
K. Einsweiler,¹⁴ E. Eisenhandler,⁷⁴ T. Ekelof,¹⁶⁵ M. El Kacimi,^{134c} M. Ellert,¹⁶⁵ S. Elles,⁴ F. Ellinghaus,⁸⁰ K. Ellis,⁷⁴
N. Ellis,²⁹ J. Elmsheuser,⁹⁷ M. Elsing,²⁹ D. Emelianov,¹²⁸ R. Engelmann,¹⁴⁷ A. Engl,⁹⁷ B. Epp,⁶⁰ A. Eppig,⁸⁶
J. Erdmann,⁵³ A. Ereditato,¹⁶ D. Eriksson,^{145a} J. Ernst,¹ M. Ernst,²⁴ J. Ernwein,¹³⁵ D. Errede,¹⁶⁴ S. Errede,¹⁶⁴
E. Ertel,⁸⁰ M. Escalier,¹¹⁴ C. Escobar,¹²² X. Espinal Curull,¹¹ B. Esposito,⁴⁶ F. Etienne,⁸² A. I. Etienne,¹³⁵
E. Etzion,¹⁵² D. Evangelakou,⁵³ H. Evans,⁵⁹ L. Fabbri,^{19a,19b} C. Fabre,²⁹ R. M. Fakhrutdinov,¹²⁷ S. Falciano,^{131a}
Y. Fang,¹⁷¹ M. Fanti,^{88a,88b} A. Farbin,⁷ A. Farilla,^{133a} J. Farley,¹⁴⁷ T. Farooque,¹⁵⁷ S. Farrell,¹⁶² S. M. Farrington,¹¹⁷
P. Farthouat,²⁹ P. Fassnacht,²⁹ D. Fassouliotis,⁸ B. Fathollahzadeh,¹⁵⁷ A. Favareto,^{88a,88b} L. Fayard,¹¹⁴ S. Fazio,^{36a,36b}
R. Febbraro,³³ P. Federic,^{143a} O. L. Fedin,¹²⁰ W. Fedorko,⁸⁷ M. Fehling-Kaschek,⁴⁷ L. Feligioni,⁸² D. Fellmann,⁵
C. Feng,^{32d} E. J. Feng,³⁰ A. B. Fenyuk,¹²⁷ J. Ferencei,^{143b} W. Fernando,⁵ S. Ferrag,⁵² J. Ferrando,⁵² V. Ferrara,⁴¹
A. Ferrari,¹⁶⁵ P. Ferrari,¹⁰⁴ R. Ferrari,^{118a} D. E. Ferreira de Lima,⁵² A. Ferrer,¹⁶⁶ D. Ferrere,⁴⁸ C. Ferretti,⁸⁶
A. Ferretto Parodi,^{49a,49b} M. Fiascaris,³⁰ F. Fiedler,⁸⁰ A. Filipčič,⁷³ F. Filthaut,¹⁰³ M. Fincke-Keeler,¹⁶⁸
M. C. N. Fiolhais,^{123a,i} L. Fiorini,¹⁶⁶ A. Firan,³⁹ G. Fischer,⁴¹ M. J. Fisher,¹⁰⁸ M. Flechl,⁴⁷ I. Fleck,¹⁴⁰ J. Fleckner,⁸⁰
P. Fleischmann,¹⁷² S. Fleischmann,¹⁷³ T. Flick,¹⁷³ A. Floderus,⁷⁸ L. R. Flores Castillo,¹⁷¹ M. J. Flowerdew,⁹⁸
T. Fonseca Martin,¹⁶ D. A. Forbush,¹³⁷ A. Formica,¹³⁵ A. Forti,⁸¹ D. Fortin,^{158a} D. Fournier,¹¹⁴ H. Fox,⁷⁰
P. Francavilla,¹¹ S. Franchino,^{118a,118b} D. Francis,²⁹ T. Frank,¹⁷⁰ M. Franklin,⁵⁶ S. Franz,²⁹ M. Fraternali,^{118a,118b}
S. Fratina,¹¹⁹ S. T. French,²⁷ C. Friedrich,⁴¹ F. Friedrich,⁴³ R. Froeschl,²⁹ D. Froidevaux,²⁹ J. A. Frost,²⁷
C. Fukunaga,¹⁵⁵ E. Fullana Torregrosa,²⁹ B. G. Fulsom,¹⁴² J. Fuster,¹⁶⁶ C. Gabaldon,²⁹ O. Gabizon,¹⁷⁰ T. Gadfort,²⁴
S. Gadomski,⁴⁸ G. Gagliardi,^{49a,49b} P. Gagnon,⁵⁹ C. Galea,⁹⁷ E. J. Gallas,¹¹⁷ V. Gallo,¹⁶ B. J. Gallop,¹²⁸ P. Gallus,¹²⁴
K. K. Gan,¹⁰⁸ Y. S. Gao,^{142,f} A. Gaponenko,¹⁴ F. Garberson,¹⁷⁴ M. Garcia-Sciveres,¹⁴ C. García,¹⁶⁶
J. E. García Navarro,¹⁶⁶ R. W. Gardner,³⁰ N. Garelli,²⁹ H. Garitaonandia,¹⁰⁴ V. Garonne,²⁹ J. Garvey,¹⁷ C. Gatti,⁴⁶
G. Gaudio,^{118a} B. Gaur,¹⁴⁰ L. Gauthier,¹³⁵ P. Gauzzi,^{131a,131b} I. L. Gavrilenko,⁹³ C. Gay,¹⁶⁷ G. Gaycken,²⁰
E. N. Gazis,⁹ P. Ge,^{32d} Z. Gecse,¹⁶⁷ C. N. P. Gee,¹²⁸ D. A. A. Geerts,¹⁰⁴ Ch. Geich-Gimbel,²⁰ K. Gellerstedt,^{145a,145b}
C. Gemme,^{49a} A. Gemmell,⁵² M. H. Genest,⁵⁴ S. Gentile,^{131a,131b} M. George,⁵³ S. George,⁷⁵ P. Gerlach,¹⁷³
A. Gershon,¹⁵² C. Geweniger,^{57a} H. Ghazlane,^{134b} N. Ghodbane,³³ B. Giacobbe,^{19a} S. Giagu,^{131a,131b}
V. Giakoumopoulou,⁸ V. Giangiobbe,¹¹ F. Gianotti,²⁹ B. Gibbard,²⁴ A. Gibson,¹⁵⁷ S. M. Gibson,²⁹ D. Gillberg,²⁸
A. R. Gillman,¹²⁸ D. M. Gingrich,^{2,e} J. Ginzburg,¹⁵² N. Giokaris,⁸ M. P. Giordani,^{163c} R. Giordano,^{101a,101b}
F. M. Giorgi,¹⁵ P. Giovannini,⁹⁸ P. F. Giraud,¹³⁵ D. Giugni,^{88a} M. Giunta,⁹² P. Giusti,^{19a} B. K. Gjelsten,¹¹⁶
L. K. Gladilin,⁹⁶ C. Glasman,⁷⁹ J. Glatzer,⁴⁷ A. Glazov,⁴¹ K. W. Glitza,¹⁷³ G. L. Glonti,⁶³ J. R. Goddard,⁷⁴
J. Godfrey,¹⁴¹ J. Godlewski,²⁹ M. Goebel,⁴¹ T. Göpfert,⁴³ C. Goeringer,⁸⁰ C. Gössling,⁴² T. Göttfert,⁹⁸ S. Goldfarb,⁸⁶
T. Golling,¹⁷⁴ A. Gomes,^{123a,c} L. S. Gomez Fajardo,⁴¹ R. Gonçalves,⁷⁵ J. Goncalves Pinto Firmino Da Costa,⁴¹
L. Gonella,²⁰ S. Gonzalez,¹⁷¹ S. González de la Hoz,¹⁶⁶ G. Gonzalez Parra,¹¹ M. L. Gonzalez Silva,²⁶
S. Gonzalez-Sevilla,⁴⁸ J. J. Goodson,¹⁴⁷ L. Goossens,²⁹ P. A. Gorbounov,⁹⁴ H. A. Gordon,²⁴ I. Gorelov,¹⁰²
G. Gorfine,¹⁷³ B. Gorini,²⁹ E. Gorini,^{71a,71b} A. Gorišek,⁷³ E. Gornicki,³⁸ B. Gosdzik,⁴¹ A. T. Goshaw,⁵
M. Gosselink,¹⁰⁴ M. I. Gostkin,⁶³ I. Gough Eschrich,¹⁶² M. Goughri,^{134a} D. Goujdami,^{134c} M. P. Goulette,⁴⁸
A. G. Goussiou,¹³⁷ C. Goy,⁴ S. Gozpinar,²² I. Grabowska-Bold,³⁷ P. Grafström,²⁹ K-J. Grahm,⁴¹ F. Grancagnolo,^{71a}
S. Grancagnolo,¹⁵ V. Grassi,¹⁴⁷ V. Gratchev,¹²⁰ N. Grau,³⁴ H. M. Gray,²⁹ J. A. Gray,¹⁴⁷ E. Graziani,^{133a}
O. G. Grebenyuk,¹²⁰ T. Greenshaw,⁷² Z. D. Greenwood,^{24,m} K. Gregersen,³⁵ I. M. Gregor,⁴¹ P. Grenier,¹⁴²
J. Griffiths,¹³⁷ N. Grigalashvili,⁶³ A. A. Grillo,¹³⁶ S. Grinstein,¹¹ Y. V. Grishkevich,⁹⁶ J.-F. Grivaz,¹¹⁴ E. Gross,¹⁷⁰
J. Grosse-Knetter,⁵³ J. Groth-Jensen,¹⁷⁰ K. Grybel,¹⁴⁰ D. Guest,¹⁷⁴ C. Guicheney,³³ A. Guida,^{71a,71b} S. Guindon,⁵³
H. Guler,^{84,o} J. Gunther,¹²⁴ B. Guo,¹⁵⁷ J. Guo,³⁴ V. N. Gushchin,¹²⁷ P. Gutierrez,¹¹⁰ N. Guttman,¹⁵² O. Gutzwiller,¹⁷¹
C. Guyot,¹³⁵ C. Gwenlan,¹¹⁷ C. B. Gwilliam,⁷² A. Haas,¹⁴² S. Haas,²⁹ C. Haber,¹⁴ H. K. Hadavand,³⁹ D. R. Hadley,¹⁷
P. Haefner,⁹⁸ F. Hahn,²⁹ S. Haider,²⁹ Z. Hajduk,³⁸ H. Hakobyan,¹⁷⁵ D. Hall,¹¹⁷ J. Haller,⁵³ K. Hamacher,¹⁷³
P. Hamal,¹¹² M. Hamer,⁵³ A. Hamilton,^{144b,p} S. Hamilton,¹⁶⁰ L. Han,^{32b} K. Hanagaki,¹¹⁵ K. Hanawa,¹⁵⁹ M. Hance,¹⁴
C. Handel,⁸⁰ P. Hanke,^{57a} J. R. Hansen,³⁵ J. B. Hansen,³⁵ J. D. Hansen,³⁵ P. H. Hansen,³⁵ P. Hansson,¹⁴² K. Hara,¹⁵⁹
G. A. Hare,¹³⁶ T. Harenberg,¹⁷³ S. Harkusha,⁸⁹ D. Harper,⁸⁶ R. D. Harrington,⁴⁵ O. M. Harris,¹³⁷ K. Harrison,¹⁷
J. Hartert,⁴⁷ F. Hartjes,¹⁰⁴ T. Haruyama,⁶⁴ A. Harvey,⁵⁵ S. Hasegawa,¹⁰⁰ Y. Hasegawa,¹³⁹ S. Hassani,¹³⁵ S. Haug,¹⁶

- M. Hauschild,²⁹ R. Hauser,⁸⁷ M. Havranek,²⁰ C. M. Hawkes,¹⁷ R. J. Hawkings,²⁹ A. D. Hawkins,⁷⁸ D. Hawkins,¹⁶² T. Hayakawa,⁶⁵ T. Hayashi,¹⁵⁹ D. Hayden,⁷⁵ H. S. Hayward,⁷² S. J. Haywood,¹²⁸ M. He,^{32d} S. J. Head,¹⁷ V. Hedberg,⁷⁸ L. Heelan,⁷ S. Heim,⁸⁷ B. Heinemann,¹⁴ S. Heisterkamp,³⁵ L. Helary,⁴ C. Heller,⁹⁷ M. Heller,²⁹ S. Hellman,^{145a,145b} D. Hellmich,²⁰ C. Helsens,¹¹ R. C. W. Henderson,⁷⁰ M. Henke,^{57a} A. Henrichs,⁵³ A. M. Henriques Correia,²⁹ S. Henrot-Versille,¹¹⁴ F. Henry-Couannier,⁸² C. Hensel,⁵³ T. Henß,¹⁷³ C. M. Hernandez,⁷ Y. Hernández Jiménez,¹⁶⁶ R. Herrberg,¹⁵ G. Hertzen,⁴⁷ R. Hertenberger,⁹⁷ L. Hervas,²⁹ G. G. Hesketh,⁷⁶ N. P. Hessey,¹⁰⁴ E. Higón-Rodríguez,¹⁶⁶ J. C. Hill,²⁷ K. H. Hiller,⁴¹ S. Hillert,²⁰ S. J. Hillier,¹⁷ I. Hinchliffe,¹⁴ E. Hines,¹¹⁹ M. Hirose,¹¹⁵ F. Hirsch,⁴² D. Hirschbuehl,¹⁷³ J. Hobbs,¹⁴⁷ N. Hod,¹⁵² M. C. Hodgkinson,¹³⁸ P. Hodgson,¹³⁸ A. Hoecker,²⁹ M. R. Hoferkamp,¹⁰² J. Hoffman,³⁹ D. Hoffmann,⁸² M. Hohlfeld,⁸⁰ M. Holder,¹⁴⁰ S. O. Holmgren,^{145a} T. Holy,¹²⁶ J. L. Holzbauer,⁸⁷ T. M. Hong,¹¹⁹ L. Hooft van Huysduynen,¹⁰⁷ C. Horn,¹⁴² S. Horner,⁴⁷ J.-Y. Hostachy,⁵⁴ S. Hou,¹⁵⁰ A. Hoummada,^{134a} J. Howarth,⁸¹ I. Hristova,¹⁵ J. Hrivnac,¹¹⁴ I. Hruska,¹²⁴ T. Hryn'ova,⁴ P. J. Hsu,⁸⁰ S.-C. Hsu,¹⁴ Z. Hubacek,¹²⁶ F. Hubaut,⁸² F. Huegging,²⁰ A. Huettmann,⁴¹ T. B. Huffman,¹¹⁷ E. W. Hughes,³⁴ G. Hughes,⁷⁰ M. Huhtinen,²⁹ M. Hurwitz,¹⁴ U. Husemann,⁴¹ N. Huseynov,^{63,q} J. Huston,⁸⁷ J. Huth,⁵⁶ G. Iacobucci,⁴⁸ G. Iakovidis,⁹ M. Ibbotson,⁸¹ I. Ibragimov,¹⁴⁰ L. Iconomidou-Fayard,¹¹⁴ J. Idarraga,¹¹⁴ P. Iengo,^{101a} O. Igonkina,¹⁰⁴ Y. Ikegami,⁶⁴ M. Ikeno,⁶⁴ D. Iliadis,¹⁵³ N. Ilic,¹⁵⁷ M. Imori,¹⁵⁴ T. Ince,²⁰ J. Inigo-Golfín,²⁹ P. Ioannou,⁸ M. Iodice,^{133a} K. Iordanidou,⁸ V. Ippolito,^{131a,131b} A. Irles Quiles,¹⁶⁶ C. Isaksson,¹⁶⁵ A. Ishikawa,⁶⁵ M. Ishino,⁶⁶ R. Ishmukhametov,³⁹ C. Issever,¹¹⁷ S. Istín,^{18a} A. V. Ivashin,¹²⁷ W. Iwanski,³⁸ H. Iwasaki,⁶⁴ J. M. Izen,⁴⁰ V. Izzo,^{101a} B. Jackson,¹¹⁹ J. N. Jackson,⁷² P. Jackson,¹⁴² M. R. Jaekel,²⁹ V. Jain,⁵⁹ K. Jakobs,⁴⁷ S. Jakobsen,³⁵ J. Jakubek,¹²⁶ D. K. Jana,¹¹⁰ E. Jansen,⁷⁶ H. Jansen,²⁹ A. Jantsch,⁹⁸ M. Janus,⁴⁷ G. Jarlskog,⁷⁸ L. Jeanty,⁵⁶ I. Jen-La Plante,³⁰ P. Jenni,²⁹ A. Jeremie,⁴ P. Jež,³⁵ S. Jézéquel,⁴ M. K. Jha,^{19a} H. Ji,¹⁷¹ W. Ji,⁸⁰ J. Jia,¹⁴⁷ Y. Jiang,^{32b} M. Jimenez Belenguer,⁴¹ S. Jin,^{32a} O. Jinnouchi,¹⁵⁶ M. D. Joergensen,³⁵ D. Joffe,³⁹ L. G. Johansen,¹³ M. Johansen,^{145a,145b} K. E. Johansson,^{145a} P. Johansson,¹³⁸ S. Johnert,⁴¹ K. A. Johns,⁶ K. Jon-And,^{145a,145b} G. Jones,¹¹⁷ R. W. L. Jones,⁷⁰ T. J. Jones,⁷² C. Joram,²⁹ P. M. Jorge,^{123a} K. D. Joshi,⁸¹ J. Jovicevic,¹⁴⁶ T. Jovin,^{12b} X. Ju,¹⁷¹ C. A. Jung,⁴² R. M. Jungst,²⁹ V. Juranek,¹²⁴ P. Jussel,⁶⁰ A. Juste Rozas,¹¹ S. Kabana,¹⁶ M. Kaci,¹⁶⁶ A. Kaczmarek,³⁸ P. Kadlecik,³⁵ M. Kado,¹¹⁴ H. Kagan,¹⁰⁸ M. Kagan,⁵⁶ E. Kajomovitz,¹⁵¹ S. Kalinin,¹⁷³ L. V. Kalinovskaya,⁶³ S. Kama,³⁹ N. Kanaya,¹⁵⁴ M. Kaneda,²⁹ S. Kaneti,²⁷ T. Kanno,¹⁵⁶ V. A. Kantserov,⁹⁵ J. Kanzaki,⁶⁴ B. Kaplan,¹⁷⁴ A. Kapliy,³⁰ J. Kaplon,²⁹ D. Kar,⁵² M. Karagounis,²⁰ M. Karnevskiy,⁴¹ V. Kartvelishvili,⁷⁰ A. N. Karyukhin,¹²⁷ L. Kashif,¹⁷¹ G. Kasieczka,^{57b} R. D. Kass,¹⁰⁸ A. Kastanas,¹³ M. Kataoka,⁴ Y. Kataoka,¹⁵⁴ E. Katsoufis,⁹ J. Katzy,⁴¹ V. Kaushik,⁶ K. Kawagoe,⁶⁸ T. Kawamoto,¹⁵⁴ G. Kawamura,⁸⁰ M. S. Kayl,¹⁰⁴ V. A. Kazanin,¹⁰⁶ M. Y. Kazarinov,⁶³ R. Keeler,¹⁶⁸ R. Kehoe,³⁹ M. Keil,⁵³ G. D. Kekelidze,⁶³ J. S. Keller,¹³⁷ J. Kennedy,⁹⁷ M. Kenyon,⁵² O. Kepka,¹²⁴ N. Kerschen,²⁹ B. P. Kerševan,⁷³ S. Kersten,¹⁷³ K. Kessoku,¹⁵⁴ J. Keung,¹⁵⁷ F. Khalil-zada,¹⁰ H. Khandanyan,¹⁶⁴ A. Khanov,¹¹¹ D. Kharchenko,⁶³ A. Khodinov,⁹⁵ A. Khomich,^{57a} T. J. Khoo,²⁷ G. Khorauli,²⁰ A. Khoroshilov,¹⁷³ V. Khovanskiy,⁹⁴ E. Khramov,⁶³ J. Khubua,^{50b} H. Kim,^{145a,145b} M. S. Kim,² S. H. Kim,¹⁵⁹ N. Kimura,¹⁶⁹ O. Kind,¹⁵ B. T. King,⁷² M. King,⁶⁵ R. S. B. King,¹¹⁷ J. Kirk,¹²⁸ A. E. Kiryunin,⁹⁸ T. Kishimoto,⁶⁵ D. Kisieleska,³⁷ T. Kittelmann,¹²² A. M. Kiver,¹²⁷ E. Kladiva,^{143b} M. Klein,⁷² U. Klein,⁷² K. Kleinknecht,⁸⁰ M. Klemetti,⁸⁴ A. Klier,¹⁷⁰ P. Klimek,^{145a,145b} A. Klimentov,²⁴ R. Klingenberg,⁴² J. A. Klinger,⁸¹ E. B. Klinkby,³⁵ T. Klioutchnikova,²⁹ P. F. Klok,¹⁰³ S. Klous,¹⁰⁴ E.-E. Kluge,^{57a} T. Kluge,⁷² P. Kluit,¹⁰⁴ S. Kluth,⁹⁸ N. S. Knecht,¹⁵⁷ E. Kneringer,⁶⁰ E. B. F. G. Knoops,⁸² A. Knue,⁵³ B. R. Ko,⁴⁴ T. Kobayashi,¹⁵⁴ M. Kobel,⁴³ M. Kocian,¹⁴² P. Kodys,¹²⁵ K. Köneke,²⁹ A. C. König,¹⁰³ S. Koenig,⁸⁰ L. Köpke,⁸⁰ F. Koetsveld,¹⁰³ P. Koevesarki,²⁰ T. Koffas,²⁸ E. Koffeman,¹⁰⁴ L. A. Kogan,¹¹⁷ S. Kohlmann,¹⁷³ F. Kohn,⁵³ Z. Kohout,¹²⁶ T. Kohriki,⁶⁴ T. Koi,¹⁴² G. M. Kolachev,¹⁰⁶ H. Kolanoski,¹⁵ V. Kolesnikov,⁶³ I. Koletsou,^{88a} J. Koll,⁸⁷ M. Kollefrath,⁴⁷ A. A. Komar,⁹³ Y. Komori,¹⁵⁴ T. Kondo,⁶⁴ T. Kono,^{41,r} A. I. Kononov,⁴⁷ R. Konoplich,^{107,s} N. Konstantinidis,⁷⁶ A. Kootz,¹⁷³ S. Koperny,³⁷ K. Korcyl,³⁸ K. Kordas,¹⁵³ A. Korn,¹¹⁷ A. Korol,¹⁰⁶ I. Korolkov,¹¹ E. V. Korolkova,¹³⁸ V. A. Korotkov,¹²⁷ O. Kortner,⁹⁸ S. Kortner,⁹⁸ V. V. Kostyukhin,²⁰ S. Kotov,⁹⁸ V. M. Kotov,⁶³ A. Kotwal,⁴⁴ C. Kourkoumelis,⁸ V. Kouskoura,¹⁵³ A. Koutsman,^{158a} R. Kowalewski,¹⁶⁸ T. Z. Kowalski,³⁷ W. Kozanecki,¹³⁵ A. S. Kozhin,¹²⁷ V. Kral,¹²⁶ V. A. Kramarenko,⁹⁶ G. Kramberger,⁷³ M. W. Krasny,⁷⁷ A. Krasznahorkay,¹⁰⁷ J. Kraus,⁸⁷ J. K. Kraus,²⁰ F. Krejci,¹²⁶ J. Kretzschmar,⁷² N. Krieger,⁵³ P. Krieger,¹⁵⁷ K. Kroeninger,⁵³ H. Kroha,⁹⁸ J. Kroll,¹¹⁹ J. Kroseberg,²⁰ J. Krstic,^{12a} U. Kruchonak,⁶³ H. Krüger,²⁰ T. Kruker,¹⁶ N. Krumnack,⁶² Z. V. Krumshcheyn,⁶³ A. Kruth,²⁰ T. Kubota,⁸⁵ S. Kuday,^{3a} S. Kuehn,⁴⁷ A. Kugel,^{57c} T. Kuhl,⁴¹ D. Kuhn,⁶⁰ V. Kukhtin,⁶³ Y. Kulchitsky,⁸⁹ S. Kuleshov,^{31b} C. Kummer,⁹⁷ M. Kuna,⁷⁷ J. Kunkle,¹¹⁹ A. Kupco,¹²⁴ H. Kurashige,⁶⁵ M. Kurata,¹⁵⁹ Y. A. Kurochkin,⁸⁹ V. Kus,¹²⁴ E. S. Kuwertz,¹⁴⁶ M. Kuze,¹⁵⁶ J. Kvita,¹⁴¹ R. Kwee,¹⁵

- A. La Rosa,⁴⁸ L. La Rotonda,^{36a,36b} L. Labarga,⁷⁹ J. Labbe,⁴ S. Lablak,^{134a} C. Lacasta,¹⁶⁶ F. Lacava,^{131a,131b}
H. Lacker,¹⁵ D. Lacour,⁷⁷ V.R. Lacuesta,¹⁶⁶ E. Ladygin,⁶³ R. Lafaye,⁴ B. Laforge,⁷⁷ T. Lagouri,⁷⁹ S. Lai,⁴⁷
E. Laisne,⁵⁴ M. Lamanna,²⁹ L. Lambourne,⁷⁶ C. L. Lampen,⁶ W. Lampl,⁶ E. Lancon,¹³⁵ U. Landgraf,⁴⁷
M. P. J. Landon,⁷⁴ J. L. Lane,⁸¹ C. Lange,⁴¹ A. J. Lankford,¹⁶² F. Lanni,²⁴ K. Lantzsche,¹⁷³ S. Laplace,⁷⁷ C. Lapoire,²⁰
J. F. Laporte,¹³⁵ T. Lari,^{88a} A. Larter,¹¹⁷ M. Lassnig,²⁹ P. Laurelli,⁴⁶ V. Lavorini,^{36a,36b} W. Lavrijsen,¹⁴ P. Laycock,⁷²
O. Le Dortz,⁷⁷ E. Le Guirriec,⁸² C. Le Maner,¹⁵⁷ E. Le Menedeu,¹¹ T. LeCompte,⁵ F. Ledroit-Guillon,⁵⁴ H. Lee,¹⁰⁴
J. S. H. Lee,¹¹⁵ S. C. Lee,¹⁵⁰ L. Lee,¹⁷⁴ M. Lefebvre,¹⁶⁸ M. Legendre,¹³⁵ B. C. LeGeyt,¹¹⁹ F. Legger,⁹⁷ C. Leggett,¹⁴
M. Lehmacher,²⁰ G. Lehmann Miotto,²⁹ X. Lei,⁶ M. A. L. Leite,^{23d} R. Leitner,¹²⁵ D. Lellouch,¹⁷⁰ B. Lemmer,⁵³
V. Lendermann,^{57a} K. J. C. Leney,^{144b} T. Lenz,¹⁰⁴ G. Lenzen,¹⁷³ B. Lenzi,²⁹ K. Leonhardt,⁴³ S. Leontsinis,⁹
F. Lepold,^{57a} C. Leroy,⁹² J.-R. Lessard,¹⁶⁸ C. G. Lester,²⁷ C. M. Lester,¹¹⁹ J. Levêque,⁴ D. Levin,⁸⁶ L. J. Levinson,¹⁷⁰
A. Lewis,¹¹⁷ G. H. Lewis,¹⁰⁷ A. M. Leyko,²⁰ M. Leyton,¹⁵ B. Li,⁸² H. Li,^{171,t} S. Li,^{32b,u} X. Li,⁸⁶ Z. Liang,^{117,v}
H. Liao,³³ B. Liberti,^{132a} P. Lichard,²⁹ M. Lichtnecker,⁹⁷ K. Lie,¹⁶⁴ W. Liebig,¹³ C. Limbach,²⁰ A. Limosani,⁸⁵
M. Limper,⁶¹ S. C. Lin,^{150,w} F. Linde,¹⁰⁴ J. T. Linnemann,⁸⁷ E. Lipeles,¹¹⁹ A. Lipniacka,¹³ T. M. Liss,¹⁶⁴
D. Lissauer,²⁴ A. Lister,⁴⁸ A. M. Litke,¹³⁶ C. Liu,²⁸ D. Liu,¹⁵⁰ H. Liu,⁸⁶ J. B. Liu,⁸⁶ M. Liu,^{32b} Y. Liu,^{32b}
M. Livan,^{118a,118b} S. S. A. Livermore,¹¹⁷ A. Lleres,⁵⁴ J. Llorente Merino,⁷⁹ S. L. Lloyd,⁷⁴ E. Lobodzinska,⁴¹ P. Loch,⁶
W. S. Lockman,¹³⁶ T. Loddenkoetter,²⁰ F. K. Loebinger,⁸¹ A. Loginov,¹⁷⁴ C. W. Loh,¹⁶⁷ T. Lohse,¹⁵ K. Lohwasser,⁴⁷
M. Lokajicek,¹²⁴ V. P. Lombardo,⁴ R. E. Long,⁷⁰ L. Lopes,^{123a} D. Lopez Mateos,⁵⁶ J. Lorenz,⁹⁷
N. Lorenzo Martinez,¹¹⁴ M. Losada,¹⁶¹ P. Loscutoff,¹⁴ F. Lo Sterzo,^{131a,131b} M. J. Losty,^{158a} X. Lou,⁴⁰ A. Lounis,¹¹⁴
K. F. Loureiro,¹⁶¹ J. Love,²¹ P. A. Love,⁷⁰ A. J. Lowe,^{142,f} F. Lu,^{32a} H. J. Lubatti,¹³⁷ C. Luci,^{131a,131b} A. Lucotte,⁵⁴
A. Ludwig,⁴³ D. Ludwig,⁴¹ I. Ludwig,⁴⁷ J. Ludwig,⁴⁷ F. Luehring,⁵⁹ G. Luijckx,¹⁰⁴ W. Lukas,⁶⁰ D. Lumb,⁴⁷
L. Luminari,^{131a} E. Lund,¹¹⁶ B. Lund-Jensen,¹⁴⁶ B. Lundberg,⁷⁸ J. Lundberg,^{145a,145b} J. Lundquist,³⁵ M. Lungwitz,⁸⁰
D. Lynn,²⁴ J. Lys,¹⁴ E. Lytken,⁷⁸ H. Ma,²⁴ L. L. Ma,¹⁷¹ J. A. Macana Goia,⁹² G. Maccarrone,⁴⁶ A. Macchiolo,⁹⁸
B. Maček,⁷³ J. Machado Miguens,^{123a} R. Mackeprang,³⁵ R. J. Madaras,¹⁴ W. F. Mader,⁴³ R. Maenner,^{57c} T. Maeno,²⁴
P. Mättig,¹⁷³ S. Mättig,⁴¹ L. Magnoni,²⁹ E. Magradze,⁵³ K. Mahboubi,⁴⁷ S. Mahmoud,⁷² G. Mahout,¹⁷
C. Maiani,^{131a,131b} C. Maidantchik,^{23a} A. Maio,^{123a,c} S. Majewski,²⁴ Y. Makida,⁶⁴ N. Makovec,¹¹⁴ P. Mal,¹³⁵
B. Malaescu,²⁹ Pa. Malecki,³⁸ P. Malecki,³⁸ V. P. Maleev,¹²⁰ F. Malek,⁵⁴ U. Mallik,⁶¹ D. Malon,⁵ C. Malone,¹⁴²
S. Maltezos,⁹ V. Malyshev,¹⁰⁶ S. Malyukov,²⁹ R. Mameghani,⁹⁷ J. Mamuzic,^{12b} A. Manabe,⁶⁴ L. Mandelli,^{88a}
I. Mandić,⁷³ R. Mandrysch,¹⁵ J. Maneira,^{123a} P. S. Mangeard,⁸⁷ L. Manhaes de Andrade Filho,^{23a} A. Mann,⁵³
P. M. Manning,¹³⁶ A. Manousakis-Katsikakis,⁸ B. Mansoulie,¹³⁵ A. Mapelli,²⁹ L. Mapelli,²⁹ L. March,⁷⁹
J. F. Marchand,²⁸ F. Marchese,^{132a,132b} G. Marchiori,⁷⁷ M. Marcisovsky,¹²⁴ C. P. Marino,¹⁶⁸ F. Marroquim,^{23a}
Z. Marshall,²⁹ F. K. Martens,¹⁵⁷ S. Marti-Garcia,¹⁶⁶ B. Martin,²⁹ B. Martin,⁸⁷ J. P. Martin,⁹² T. A. Martin,¹⁷
V. J. Martin,⁴⁵ B. Martin dit Latour,⁴⁸ S. Martin-Haugh,¹⁴⁸ M. Martinez,¹¹ V. Martinez Outschoorn,⁵⁶
A. C. Martyniuk,¹⁶⁸ M. Marx,⁸¹ F. Marzano,^{131a} A. Marzin,¹¹⁰ L. Masetti,⁸⁰ T. Mashimo,¹⁵⁴ R. Mashinistov,⁹³
J. Masik,⁸¹ A. L. Maslennikov,¹⁰⁶ I. Massa,^{19a,19b} G. Massaro,¹⁰⁴ N. Massol,⁴ P. Mastrandrea,^{131a,131b}
A. Mastroberardino,^{36a,36b} T. Masubuchi,¹⁵⁴ P. Matricon,¹¹⁴ H. Matsunaga,¹⁵⁴ T. Matsushita,⁶⁵ C. Mattravers,^{117,d}
J. Maurer,⁸² S. J. Maxfield,⁷² A. Mayne,¹³⁸ R. Mazini,¹⁵⁰ M. Mazur,²⁰ L. Mazzaferro,^{132a,132b} M. Mazzanti,^{88a}
S. P. Mc Kee,⁸⁶ A. McCarn,¹⁶⁴ R. L. McCarthy,¹⁴⁷ T. G. McCarthy,²⁸ N. A. McCubbin,¹²⁸ K. W. McFarlane,⁵⁵
J. A. Mcfayden,¹³⁸ H. McGlone,⁵² G. Mchedlidze,^{50b} T. McLaughlan,¹⁷ S. J. McMahon,¹²⁸ R. A. McPherson,^{168,k}
A. Meade,⁸³ J. Mechnich,¹⁰⁴ M. Mechtel,¹⁷³ M. Medinnis,⁴¹ R. Meera-Lebbai,¹¹⁰ T. Meguro,¹¹⁵ S. Mehlhase,³⁵
A. Mehta,⁷² K. Meier,^{57a} B. Meirose,⁷⁸ C. Melachrinou,³⁰ B. R. Mellado Garcia,¹⁷¹ F. Meloni,^{88a,88b}
L. Mendoza Navas,¹⁶¹ Z. Meng,^{150,t} A. Mengarelli,^{19a,19b} S. Menke,⁹⁸ E. Meoni,¹¹ K. M. Mercurio,⁵⁶ P. Mermod,⁴⁸
L. Merola,^{101a,101b} C. Meroni,^{88a} F. S. Merritt,³⁰ H. Merritt,¹⁰⁸ A. Messina,^{29,x} J. Metcalfe,¹⁰² A. S. Mete,⁶²
C. Meyer,⁸⁰ C. Meyer,³⁰ J.-P. Meyer,¹³⁵ J. Meyer,¹⁷² J. Meyer,⁵³ T. C. Meyer,²⁹ W. T. Meyer,⁶² J. Miao,^{32d} S. Michal,²⁹
L. Micu,^{25a} R. P. Middleton,¹²⁸ S. Migas,⁷² L. Mijović,⁴¹ G. Mikenberg,¹⁷⁰ M. Mikesikova,¹²⁴ M. Mikuž,⁷³
D. W. Miller,³⁰ R. J. Miller,⁸⁷ W. J. Mills,¹⁶⁷ C. Mills,⁵⁶ A. Milov,¹⁷⁰ D. A. Milstead,^{145a,145b} D. Milstein,¹⁷⁰
A. A. Minaenko,¹²⁷ M. Miñano Moya,¹⁶⁶ I. A. Minashvili,⁶³ A. I. Mincer,¹⁰⁷ B. Mindur,³⁷ M. Mineev,⁶³ Y. Ming,¹⁷¹
L. M. Mir,¹¹ G. Mirabelli,^{131a} J. Mitrevski,¹³⁶ V. A. Mitsou,¹⁶⁶ S. Mitsui,⁶⁴ P. S. Miyagawa,¹³⁸ K. Miyazaki,⁶⁵
J. U. Mjörnmark,⁷⁸ T. Moa,^{145a,145b} P. Mockett,¹³⁷ S. Moed,⁵⁶ V. Moeller,²⁷ K. Mönig,⁴¹ N. Möser,²⁰
S. Mohapatra,¹⁴⁷ W. Mohr,⁴⁷ R. Moles-Valls,¹⁶⁶ J. Molina-Perez,²⁹ J. Monk,⁷⁶ E. Monnier,⁸² S. Montesano,^{88a,88b}
F. Monticelli,⁶⁹ S. Monzani,^{19a,19b} R. W. Moore,² G. F. Moorhead,⁸⁵ C. Mora Herrera,⁴⁸ A. Moraes,⁵² N. Morange,¹³⁵
J. Morel,⁵³ G. Morello,^{36a,36b} D. Moreno,⁸⁰ M. Moreno Llácer,¹⁶⁶ P. Morettini,^{49a} M. Morgenstern,⁴³ M. Morii,⁵⁶

- J. Morin,⁷⁴ A. K. Morley,²⁹ G. Mornacchi,²⁹ J. D. Morris,⁷⁴ L. Morvaj,¹⁰⁰ H. G. Moser,⁹⁸ M. Mosidze,^{50b} J. Moss,¹⁰⁸ R. Mount,¹⁴² E. Mountricha,^{9,y} S. V. Mouraviev,⁹³ E. J. W. Moyse,⁸³ F. Mueller,^{57a} J. Mueller,¹²² K. Mueller,²⁰ T. A. Müller,⁹⁷ T. Mueller,⁸⁰ D. Muenstermann,²⁹ Y. Munwes,¹⁵² W. J. Murray,¹²⁸ I. Mussche,¹⁰⁴ E. Musto,^{101a,101b} A. G. Myagkov,¹²⁷ M. Myska,¹²⁴ J. Nadal,¹¹ K. Nagai,¹⁵⁹ K. Nagano,⁶⁴ A. Nagarkar,¹⁰⁸ Y. Nagasaka,⁵⁸ M. Nagel,⁹⁸ A. M. Nairz,²⁹ Y. Nakahama,²⁹ K. Nakamura,¹⁵⁴ T. Nakamura,¹⁵⁴ I. Nakano,¹⁰⁹ G. Nanava,²⁰ A. Napier,¹⁶⁰ R. Narayan,^{57b} M. Nash,^{76,d} T. Nattermann,²⁰ T. Naumann,⁴¹ G. Navarro,¹⁶¹ H. A. Neal,⁸⁶ P. Yu. Nechaeva,⁹³ T. J. Neep,⁸¹ A. Negri,^{118a,118b} G. Negri,²⁹ S. Nektarijevic,⁴⁸ A. Nelson,¹⁶² T. K. Nelson,¹⁴² S. Nemecek,¹²⁴ P. Nemethy,¹⁰⁷ A. A. Nepomuceno,^{23a} M. Nessi,^{29,z} M. S. Neubauer,¹⁶⁴ A. Neusiedl,⁸⁰ R. M. Neves,¹⁰⁷ P. Nevski,²⁴ P. R. Newman,¹⁷ V. Nguyen Thi Hong,¹³⁵ R. B. Nickerson,¹¹⁷ R. Nicolaidou,¹³⁵ L. Nicolas,¹³⁸ B. Niquevert,²⁹ F. Niedercorn,¹¹⁴ J. Nielsen,¹³⁶ N. Nikiforou,³⁴ A. Nikiforov,¹⁵ V. Nikolaenko,¹²⁷ I. Nikolic-Audit,⁷⁷ K. Nikolics,⁴⁸ K. Nikolopoulos,²⁴ H. Nilsen,⁴⁷ P. Nilsson,⁷ Y. Ninomiya,¹⁵⁴ A. Nisati,^{131a} T. Nishiyama,⁶⁵ R. Nisius,⁹⁸ L. Nodulman,⁵ M. Nomachi,¹¹⁵ I. Nomidis,¹⁵³ M. Nordberg,²⁹ P. R. Norton,¹²⁸ J. Novakova,¹²⁵ M. Nozaki,⁶⁴ L. Nozka,¹¹² I. M. Nugent,^{158a} A.-E. Nuncio-Quiroz,²⁰ G. Nunes Hanninger,⁸⁵ T. Nunnemann,⁹⁷ E. Nurse,⁷⁶ B. J. O'Brien,⁴⁵ S. W. O'Neale,^{17,a} D. C. O'Neil,¹⁴¹ V. O'Shea,⁵² L. B. Oakes,⁹⁷ F. G. Oakham,^{28,e} H. Oberlack,⁹⁸ J. Ocariz,⁷⁷ A. Ochi,⁶⁵ S. Oda,¹⁵⁴ S. Odaka,⁶⁴ J. Odier,⁸² H. Ogren,⁵⁹ A. Oh,⁸¹ S. H. Oh,⁴⁴ C. C. Ohm,^{145a,145b} T. Ohshima,¹⁰⁰ S. Okada,⁶⁵ H. Okawa,¹⁶² Y. Okumura,¹⁰⁰ T. Okuyama,¹⁵⁴ A. Olariu,^{25a} A. G. Olchevski,⁶³ S. A. Olivares Pino,^{31a} M. Oliveira,^{123a,i} D. Oliveira Damazio,²⁴ E. Oliver Garcia,¹⁶⁶ D. Olivito,¹¹⁹ A. Olszewski,³⁸ J. Olszowska,³⁸ A. Onofre,^{123a,aa} P. U. E. Onyisi,³⁰ C. J. Oram,^{158a} M. J. Oreglia,³⁰ Y. Oren,¹⁵² D. Orestano,^{133a,133b} N. Orlando,^{71a,71b} I. Orlov,¹⁰⁶ C. Oropeza Barrera,⁵² R. S. Orr,¹⁵⁷ B. Osculati,^{49a,49b} R. Ospanov,¹¹⁹ C. Osuna,¹¹ G. Otero y Garzon,²⁶ J. P. Ottersbach,¹⁰⁴ M. Ouchrif,^{134d} E. A. Ouellette,¹⁶⁸ F. Ould-Saada,¹¹⁶ A. Ouraou,¹³⁵ Q. Ouyang,^{32a} A. Ovcharova,¹⁴ M. Owen,⁸¹ S. Owen,¹³⁸ V. E. Ozcan,^{18a} N. Ozturk,⁷ A. Pacheco Pages,¹¹ C. Padilla Aranda,¹¹ S. Pagan Griso,¹⁴ E. Paganis,¹³⁸ F. Paige,²⁴ P. Pais,⁸³ K. Pajchel,¹¹⁶ G. Palacino,^{158b} C. P. Paleari,⁶ S. Palestini,²⁹ D. Pallin,³³ A. Palma,^{123a} J. D. Palmer,¹⁷ Y. B. Pan,¹⁷¹ E. Panagiotopoulou,⁹ N. Panikashvili,⁸⁶ S. Panitkin,²⁴ D. Pantea,^{25a} A. Papadelis,^{145a} Th. D. Papadopoulou,⁹ A. Paramonov,⁵ D. Paredes Hernandez,³³ W. Park,^{24,bb} M. A. Parker,²⁷ F. Parodi,^{49a,49b} J. A. Parsons,³⁴ U. Parzefall,⁴⁷ S. Pashapour,⁵³ E. Pasqualucci,^{131a} S. Passaggio,^{49a} A. Passeri,^{133a} F. Pastore,^{133a,133b} Fr. Pastore,⁷⁵ G. Pásztor,^{48,cc} S. Pataraiia,¹⁷³ N. Patel,¹⁴⁹ J. R. Pater,⁸¹ S. Patricelli,^{101a,101b} T. Pauly,²⁹ M. Pecsý,^{143a} M. I. Pedraza Morales,¹⁷¹ S. V. Peleganchuk,¹⁰⁶ D. Pelikan,¹⁶⁵ H. Peng,^{32b} B. Penning,³⁰ A. Penson,³⁴ J. Penwell,⁵⁹ M. Perantoni,^{23a} K. Perez,^{34,dd} T. Perez Cavalcanti,⁴¹ E. Perez Codina,^{158a} M. T. Pérez García-Estañ,¹⁶⁶ V. Perez Reale,³⁴ L. Perini,^{88a,88b} H. Pernegger,²⁹ R. Perrino,^{71a} P. Perrodo,⁴ S. Persebe,^{3a} V. D. Peshekhonov,⁶³ K. Peters,²⁹ B. A. Petersen,²⁹ J. Petersen,²⁹ T. C. Petersen,³⁵ E. Petit,⁴ A. Petridis,¹⁵³ C. Petridou,¹⁵³ E. Petrolo,^{131a} F. Petrucci,^{133a,133b} D. Petschull,⁴¹ M. Petteni,¹⁴¹ R. Pezoa,^{31b} A. Phan,⁸⁵ P. W. Phillips,¹²⁸ G. Piacquadio,²⁹ A. Picazio,⁴⁸ E. Piccaro,⁷⁴ M. Piccinini,^{19a,19b} S. M. Piec,⁴¹ R. Piegaiia,²⁶ D. T. Pignotti,¹⁰⁸ J. E. Pilcher,³⁰ A. D. Pilkington,⁸¹ J. Pina,^{123a,c} M. Pinamonti,^{163a,163c} A. Pinder,¹¹⁷ J. L. Pinfold,² B. Pinto,^{123a} C. Pizio,^{88a,88b} M. Plamondon,¹⁶⁸ M.-A. Pleier,²⁴ E. Plotnikova,⁶³ A. Poblaguev,²⁴ S. Poddar,^{57a} F. Podlyski,³³ L. Poggioli,¹¹⁴ T. Poghosyan,²⁰ M. Pohl,⁴⁸ F. Polci,⁵⁴ G. Polesello,^{118a} A. Policicchio,^{36a,36b} A. Polini,^{19a} J. Poll,⁷⁴ V. Polychronakos,²⁴ D. M. Pomarede,¹³⁵ D. Pomeroy,²² K. Pommès,²⁹ L. Pontecorvo,^{131a} B. G. Pope,⁸⁷ G. A. Popeneciu,^{25a} D. S. Popovic,^{12a} A. Poppleton,²⁹ X. Portell Bueso,²⁹ G. E. Pospelov,⁹⁸ S. Pospisil,¹²⁶ I. N. Potrap,⁹⁸ C. J. Potter,¹⁴⁸ C. T. Potter,¹¹³ G. Poulard,²⁹ J. Poveda,¹⁷¹ V. Pozdnyakov,⁶³ R. Prabhu,⁷⁶ P. Pralavorio,⁸² A. Pranko,¹⁴ S. Prasad,²⁹ R. Pravahan,²⁴ S. Prell,⁶² K. Pretzl,¹⁶ D. Price,⁵⁹ J. Price,⁷² L. E. Price,⁵ D. Prieur,¹²² M. Primavera,^{71a} K. Prokofiev,¹⁰⁷ F. Prokoshin,^{31b} S. Protopopescu,²⁴ J. Proudfoot,⁵ X. Prudent,⁴³ M. Przybycien,³⁷ H. Przysieznik,⁴ S. Psoroulas,²⁰ E. Ptacek,¹¹³ E. Pueschel,⁸³ J. Purdham,⁸⁶ M. Purohit,^{24,bb} P. Puzo,¹¹⁴ Y. Pylypchenko,⁶¹ J. Qian,⁸⁶ Z. Qin,⁴¹ A. Quadt,⁵³ D. R. Quarrie,¹⁴ W. B. Quayle,¹⁷¹ F. Quinonez,^{31a} M. Raas,¹⁰³ V. Radescu,⁴¹ P. Radloff,¹¹³ T. Rador,^{18a} F. Ragusa,^{88a,88b} G. Rahal,¹⁷⁶ A. M. Rahimi,¹⁰⁸ D. Rahm,²⁴ S. Rajagopalan,²⁴ M. Rammensee,⁴⁷ M. Rammes,¹⁴⁰ A. S. Randle-Conde,³⁹ K. Randrianarivony,²⁸ F. Rauscher,⁹⁷ T. C. Rave,⁴⁷ M. Raymond,²⁹ A. L. Read,¹¹⁶ D. M. Rebutzi,^{118a,118b} A. Redelbach,¹⁷² G. Redlinger,²⁴ R. Reece,¹¹⁹ K. Reeves,⁴⁰ E. Reinherz-Aronis,¹⁵² A. Reinsch,¹¹³ I. Reisinger,⁴² C. Rembser,²⁹ Z. L. Ren,¹⁵⁰ A. Renaud,¹¹⁴ M. Rescigno,^{131a} S. Resconi,^{88a} B. Resende,¹³⁵ P. Reznicek,⁹⁷ R. Rezvani,¹⁵⁷ R. Richter,⁹⁸ E. Richter-Was,^{4,ee} M. Ridet,⁷⁷ M. Rijpsstra,¹⁰⁴ M. Rijssenbeek,¹⁴⁷ A. Rimoldi,^{118a,118b} L. Rinaldi,^{19a} R. R. Rios,³⁹ I. Riu,¹¹ G. Rivoltella,^{88a,88b} F. Rizatdinova,¹¹¹ E. Rizvi,⁷⁴ S. H. Robertson,^{84,k} A. Robichaud-Veronneau,¹¹⁷ D. Robinson,²⁷ J. E. M. Robinson,⁷⁶ A. Robson,⁵² J. G. Rocha de Lima,¹⁰⁵ C. Roda,^{121a,121b} D. Roda Dos Santos,²⁹ D. Rodriguez,¹⁶¹

- A. Roe,⁵³ S. Roe,²⁹ O. Röhne,¹¹⁶ S. Rolli,¹⁶⁰ A. Romaniouk,⁹⁵ M. Romano,^{19a,19b} G. Romeo,²⁶ E. Romero Adam,¹⁶⁶ L. Roos,⁷⁷ E. Ros,¹⁶⁶ S. Rosati,^{131a} K. Rosbach,⁴⁸ A. Rose,¹⁴⁸ M. Rose,⁷⁵ G. A. Rosenbaum,¹⁵⁷ E. I. Rosenberg,⁶² P. L. Rosendahl,¹³ O. Rosenthal,¹⁴⁰ L. Rossetlet,⁴⁸ V. Rossetti,¹¹ E. Rossi,^{131a,131b} L. P. Rossi,^{49a} M. Rotaru,^{25a} I. Roth,¹⁷⁰ J. Rothberg,¹³⁷ D. Rousseau,¹¹⁴ C. R. Royon,¹³⁵ A. Rozanov,⁸² Y. Rozen,¹⁵¹ X. Ruan,^{32a,ff} F. Rubbo,¹¹ I. Rubinskiy,⁴¹ B. Ruckert,⁹⁷ N. Ruckstuhl,¹⁰⁴ V. I. Rud,⁹⁶ C. Rudolph,⁴³ G. Rudolph,⁶⁰ F. Rühr,⁶ F. Ruggieri,^{133a,133b} A. Ruiz-Martinez,⁶² L. Rumyantsev,⁶³ K. Runge,⁴⁷ Z. Rurikova,⁴⁷ N. A. Rusakovich,⁶³ J. P. Rutherford,⁶ C. Ruwiedel,¹⁴ P. Ruzicka,¹²⁴ Y. F. Ryabov,¹²⁰ P. Ryan,⁸⁷ M. Rybar,¹²⁵ G. Rybkin,¹¹⁴ N. C. Ryder,¹¹⁷ A. F. Saavedra,¹⁴⁹ I. Sadeh,¹⁵² H. F. W. Sadrozinski,¹³⁶ R. Sadykov,⁶³ F. Safai Tehrani,^{131a} H. Sakamoto,¹⁵⁴ G. Salamanna,⁷⁴ A. Salamon,^{132a} M. Saleem,¹¹⁰ D. Salek,²⁹ D. Salihagic,⁹⁸ A. Salnikov,¹⁴² J. Salt,¹⁶⁶ B. M. Salvachua Ferrando,⁵ D. Salvatore,^{36a,36b} F. Salvatore,¹⁴⁸ A. Salvucci,¹⁰³ A. Salzburger,²⁹ D. Sampsonidis,¹⁵³ B. H. Samset,¹¹⁶ A. Sanchez,^{101a,101b} V. Sanchez Martinez,¹⁶⁶ H. Sandaker,¹³ H. G. Sander,⁸⁰ M. P. Sanders,⁹⁷ M. Sandhoff,¹⁷³ T. Sandoval,²⁷ C. Sandoval,¹⁶¹ R. Sandstroem,⁹⁸ D. P. C. Sankey,¹²⁸ A. Sansoni,⁴⁶ C. Santamarina Rios,⁸⁴ C. Santoni,³³ R. Santonico,^{132a,132b} H. Santos,^{123a} J. G. Saraiva,^{123a} T. Sarangi,¹⁷¹ E. Sarkisyan-Grinbaum,⁷ F. Sarri,^{121a,121b} G. Sartisohn,¹⁷³ O. Sasaki,⁶⁴ N. Sasao,⁶⁶ I. Satsounkevitch,⁸⁹ G. Sauvage,⁴ E. Sauvan,⁴ J. B. Sauvan,¹¹⁴ P. Savard,^{157,e} V. Savinov,¹²² D. O. Savu,²⁹ L. Sawyer,^{24,m} D. H. Saxon,⁵² J. Saxon,¹¹⁹ C. Sbarra,^{19a} A. Sbrizzi,^{19a,19b} O. Scallan,⁹² D. A. Scannicchio,¹⁶² M. Scarcella,¹⁴⁹ J. Schaarschmidt,¹¹⁴ P. Schacht,⁹⁸ D. Schaefer,¹¹⁹ U. Schäfer,⁸⁰ S. Schaepe,²⁰ S. Schaezel,^{57b} A. C. Schaffer,¹¹⁴ D. Schaile,⁹⁷ R. D. Schamberger,¹⁴⁷ A. G. Schamov,¹⁰⁶ V. Scharf,^{57a} V. A. Schegelsky,¹²⁰ D. Scheirich,⁸⁶ M. Schernau,¹⁶² M. I. Scherzer,³⁴ C. Schiavi,^{49a,49b} J. Schieck,⁹⁷ M. Schioppa,^{36a,36b} S. Schlenker,²⁹ E. Schmidt,⁴⁷ K. Schmieden,²⁰ C. Schmitt,⁸⁰ S. Schmitt,^{57b} M. Schmitz,²⁰ A. Schöning,^{57b} M. Schott,²⁹ D. Schouten,^{158a} J. Schovancova,¹²⁴ M. Schram,⁸⁴ C. Schroeder,⁸⁰ N. Schroer,^{57c} M. J. Schultens,²⁰ J. Schultes,¹⁷³ H.-C. Schultz-Coulon,^{57a} H. Schulz,¹⁵ J. W. Schumacher,²⁰ M. Schumacher,⁴⁷ B. A. Schumm,¹³⁶ Ph. Schune,¹³⁵ C. Schwanenberger,⁸¹ A. Schwartzman,¹⁴² Ph. Schwemling,⁷⁷ R. Schwienhorst,⁸⁷ R. Schwierz,⁴³ J. Schwindling,¹³⁵ T. Schwindt,²⁰ M. Schwoerer,⁴ G. Sciolla,²² W. G. Scott,¹²⁸ J. Searcy,¹¹³ G. Sedov,⁴¹ E. Sedykh,¹²⁰ S. C. Seidel,¹⁰² A. Seiden,¹³⁶ F. Seifert,⁴³ J. M. Seixas,^{23a} G. Sekhniaidze,^{101a} S. J. Sekula,³⁹ K. E. Selbach,⁴⁵ D. M. Seliverstov,¹²⁰ B. Sellden,^{145a} G. Sellers,⁷² M. Seman,^{143b} N. Semprini-Cesari,^{19a,19b} C. Serfon,⁹⁷ L. Serin,¹¹⁴ L. Serkin,⁵³ R. Seuster,⁹⁸ H. Severini,¹¹⁰ A. Sfyrila,²⁹ E. Shabalina,⁵³ M. Shamim,¹¹³ L. Y. Shan,^{32a} J. T. Shank,²¹ Q. T. Shao,⁸⁵ M. Shapiro,¹⁴ P. B. Shatalov,⁹⁴ K. Shaw,^{163a,163c} D. Sherman,¹⁷⁴ P. Sherwood,⁷⁶ A. Shibata,¹⁰⁷ H. Shichi,¹⁰⁰ S. Shimizu,²⁹ M. Shimojima,⁹⁹ T. Shin,⁵⁵ M. Shiyakova,⁶³ A. Shmeleva,⁹³ M. J. Shochet,³⁰ D. Short,¹¹⁷ S. Shrestha,⁶² E. Shulga,⁹⁵ M. A. Shupe,⁶ P. Sicho,¹²⁴ A. Sidoti,^{131a} F. Siegert,⁴⁷ Dj. Sijacki,^{12a} O. Silbert,¹⁷⁰ J. Silva,^{123a} Y. Silver,¹⁵² D. Silverstein,¹⁴² S. B. Silverstein,^{145a} V. Simak,¹²⁶ O. Simard,¹³⁵ Lj. Simic,^{12a} S. Simion,¹¹⁴ B. Simmons,⁷⁶ R. Simoniello,^{88a,88b} M. Simonyan,³⁵ P. Sinervo,¹⁵⁷ N. B. Sinev,¹¹³ V. Sipica,¹⁴⁰ G. Siragusa,¹⁷² A. Sircar,²⁴ A. N. Sisakyan,⁶³ S. Yu. Sivoklov,⁹⁶ J. Sjölin,^{145a,145b} T. B. Sjursen,¹³ L. A. Skinnari,¹⁴ H. P. Skottowe,⁵⁶ K. Skovpen,¹⁰⁶ P. Skubic,¹¹⁰ M. Slater,¹⁷ T. Slavicek,¹²⁶ K. Sliwa,¹⁶⁰ V. Smakhtin,¹⁷⁰ B. H. Smart,⁴⁵ S. Yu. Smirnov,⁹⁵ Y. Smirnov,⁹⁵ L. N. Smirnova,⁹⁶ O. Smirnova,⁷⁸ B. C. Smith,⁵⁶ D. Smith,¹⁴² K. M. Smith,⁵² M. Smizanska,⁷⁰ K. Smolek,¹²⁶ A. A. Snesarev,⁹³ S. W. Snow,⁸¹ J. Snow,¹¹⁰ S. Snyder,²⁴ R. Sobie,^{168,k} J. Sodomka,¹²⁶ A. Soffer,¹⁵² C. A. Solans,¹⁶⁶ M. Solar,¹²⁶ J. Solc,¹²⁶ E. Soldatov,⁹⁵ U. Soldevila,¹⁶⁶ E. Solfaroli Camillocci,^{131a,131b} A. A. Solodkov,¹²⁷ O. V. Solovyanov,¹²⁷ N. Soni,² V. Sopko,¹²⁶ B. Sopko,¹²⁶ M. Sosebee,⁷ R. Soualah,^{163a,163c} A. Soukharev,¹⁰⁶ S. Spagnolo,^{71a,71b} F. Spanò,⁷⁵ R. Spighi,^{19a} G. Spigo,²⁹ F. Spila,^{131a,131b} R. Spiwoks,²⁹ M. Spousta,¹²⁵ T. Spreitzer,¹⁵⁷ B. Spurlock,⁷ R. D. St. Denis,⁵² J. Stahlman,¹¹⁹ R. Stamen,^{57a} E. Stanecka,³⁸ R. W. Stanek,⁵ C. Stancu,^{133a} M. Stancu-Bellu,⁴¹ S. Stapnes,¹¹⁶ E. A. Starchenko,¹²⁷ J. Stark,⁵⁴ P. Staroba,¹²⁴ P. Starovoitov,⁴¹ A. Staude,⁹⁷ P. Stavina,^{143a} G. Steele,⁵² P. Steinbach,⁴³ P. Steinberg,²⁴ I. Stekl,¹²⁶ B. Stelzer,¹⁴¹ H. J. Stelzer,⁸⁷ O. Stelzer-Chilton,^{158a} H. Stenzel,⁵¹ S. Stern,⁹⁸ G. A. Stewart,²⁹ J. A. Stillings,²⁰ M. C. Stockton,⁸⁴ K. Stoerig,⁴⁷ G. Stoicea,^{25a} S. Stonjek,⁹⁸ P. Strachota,¹²⁵ A. R. Stradling,⁷ A. Straessner,⁴³ J. Strandberg,¹⁴⁶ S. Strandberg,^{145a,145b} A. Strandlie,¹¹⁶ M. Strang,¹⁰⁸ E. Strauss,¹⁴² M. Strauss,¹¹⁰ P. Strizenec,^{143b} R. Ströhmer,¹⁷² D. M. Strom,¹¹³ J. A. Strong,^{75,a} R. Stroynowski,³⁹ J. Strube,¹²⁸ B. Stugu,¹³ I. Stumer,^{24,a} J. Stupak,¹⁴⁷ P. Sturm,¹⁷³ N. A. Styles,⁴¹ D. A. Soh,^{150,v} D. Su,¹⁴² H. S. Subramania,² A. Succurro,¹¹ Y. Sugaya,¹¹⁵ C. Suhr,¹⁰⁵ K. Suita,⁶⁵ M. Suk,¹²⁵ V. V. Sulin,⁹³ S. Sultansoy,^{3d} T. Sumida,⁶⁶ X. Sun,⁵⁴ J. E. Sundermann,⁴⁷ K. Suruliz,¹³⁸ G. Susinno,^{36a,36b} M. R. Sutton,¹⁴⁸ Y. Suzuki,⁶⁴ Y. Suzuki,⁶⁵ M. Svatos,¹²⁴ S. Swedish,¹⁶⁷ I. Sykora,^{143a} T. Sykora,¹²⁵ J. Sánchez,¹⁶⁶ D. Ta,¹⁰⁴ K. Tackmann,⁴¹ A. Taffard,¹⁶² R. Tafirout,^{158a} N. Taiblum,¹⁵² Y. Takahashi,¹⁰⁰ H. Takai,²⁴ R. Takashima,⁶⁷ H. Takeda,⁶⁵ T. Takeshita,¹³⁹ Y. Takubo,⁶⁴ M. Talby,⁸² A. Talyshev,^{106,g} M. C. Tamsett,²⁴ J. Tanaka,¹⁵⁴ R. Tanaka,¹¹⁴

- S. Tanaka,¹³⁰ S. Tanaka,⁶⁴ A. J. Tanasijczuk,¹⁴¹ K. Tani,⁶⁵ N. Tannoury,⁸² S. Tapprogge,⁸⁰ D. Tardif,¹⁵⁷ S. Tarem,¹⁵¹ F. Tarrade,²⁸ G. F. Tartarelli,^{88a} P. Tas,¹²⁵ M. Tasevsky,¹²⁴ E. Tassi,^{36a,36b} M. Tatarkhanov,¹⁴ Y. Tayalati,^{134d} C. Taylor,⁷⁶ F. E. Taylor,⁹¹ G. N. Taylor,⁸⁵ W. Taylor,^{158b} M. Teinturier,¹¹⁴ M. Teixeira Dias Castanheira,⁷⁴ P. Teixeira-Dias,⁷⁵ K. K. Temming,⁴⁷ H. Ten Kate,²⁹ P. K. Teng,¹⁵⁰ S. Terada,⁶⁴ K. Terashi,¹⁵⁴ J. Terron,⁷⁹ M. Testa,⁴⁶ R. J. Teuscher,^{157,k} J. Therhaag,²⁰ T. Thevenaux-Pelzer,⁷⁷ M. Thioye,¹⁷⁴ S. Thoma,⁴⁷ J. P. Thomas,¹⁷ E. N. Thompson,³⁴ P. D. Thompson,¹⁷ P. D. Thompson,¹⁵⁷ A. S. Thompson,⁵² L. A. Thomsen,³⁵ E. Thomson,¹¹⁹ M. Thomson,²⁷ R. P. Thun,⁸⁶ F. Tian,³⁴ M. J. Tibbetts,¹⁴ T. Tic,¹²⁴ V. O. Tikhomirov,⁹³ Y. A. Tikhonov,^{106,g} S. Timoshenko,⁹⁵ P. Tipton,¹⁷⁴ F. J. Tique Aires Viegas,²⁹ S. Tisserant,⁸² T. Todorov,⁴ S. Todorova-Nova,¹⁶⁰ B. Toggerson,¹⁶² J. Tojo,⁶⁸ S. Tokár,^{143a} K. Tokunaga,⁶⁵ K. Tokushuku,⁶⁴ K. Tollefson,⁸⁷ M. Tomoto,¹⁰⁰ L. Tompkins,³⁰ K. Toms,¹⁰² A. Tonoyan,¹³ C. Topfel,¹⁶ N. D. Topilin,⁶³ I. Torchiani,²⁹ E. Torrence,¹¹³ H. Torres,⁷⁷ E. Torró Pastor,¹⁶⁶ J. Toth,^{82,cc} F. Touchard,⁸² D. R. Tovey,¹³⁸ T. Trefzger,¹⁷² L. Tremblet,²⁹ A. Tricoli,²⁹ I. M. Trigger,^{158a} S. Trincas-Duvoid,⁷⁷ M. F. Tripana,⁶⁹ W. Trischuk,¹⁵⁷ B. Trocmé,⁵⁴ C. Troncon,^{88a} M. Trotter-McDonald,¹⁴¹ M. Trzebinski,³⁸ A. Trzupek,³⁸ C. Tsarouchas,²⁹ J. C.-L. Tseng,¹¹⁷ M. Tsiakiris,¹⁰⁴ P. V. Tsiareshka,⁸⁹ D. Tsionou,^{4,gg} G. Tsipolitis,⁹ V. Tsiskaridze,⁴⁷ E. G. Tskhadadze,^{50a} I. I. Tsukerman,⁹⁴ V. Tsulaia,¹⁴ J.-W. Tsung,²⁰ S. Tsuno,⁶⁴ D. Tsybychev,¹⁴⁷ A. Tua,¹³⁸ A. Tudorache,^{25a} V. Tudorache,^{25a} J. M. Tuggle,³⁰ M. Turala,³⁸ D. Turecek,¹²⁶ I. Turk Cakir,^{3e} E. Turlay,¹⁰⁴ R. Turra,^{88a,88b} P. M. Tuts,³⁴ A. Tykhonov,⁷³ M. Tylmad,^{145a,145b} M. Tyndel,¹²⁸ G. Tzanakos,⁸ K. Uchida,²⁰ I. Ueda,¹⁵⁴ R. Ueno,²⁸ M. Ugland,¹³ M. Uhlenbrock,²⁰ M. Uhrmacher,⁵³ F. Ukegawa,¹⁵⁹ G. Unal,²⁹ A. Undrus,²⁴ G. Unel,¹⁶² Y. Unno,⁶⁴ D. Urbaniec,³⁴ G. Usai,⁷ M. Uslenghi,^{118a,118b} L. Vacavant,⁸² V. Vacek,¹²⁶ B. Vachon,⁸⁴ S. Vahsen,¹⁴ J. Valenta,¹²⁴ P. Valente,^{131a} S. Valentinetti,^{19a,19b} S. Valkar,¹²⁵ E. Valladolid Gallego,¹⁶⁶ S. Vallecorsa,¹⁵¹ J. A. Valls Ferrer,¹⁶⁶ H. van der Graaf,¹⁰⁴ E. van der Kraaij,¹⁰⁴ R. Van Der Leeuw,¹⁰⁴ E. van der Poel,¹⁰⁴ D. van der Ster,²⁹ N. van Eldik,⁸³ P. van Gemmeren,⁵ I. van Vulpen,¹⁰⁴ M. Vanadia,⁹⁸ W. Vandelli,²⁹ A. Vaniachine,⁵ P. Vankov,⁴¹ F. Vannucci,⁷⁷ R. Vari,^{131a} T. Varol,⁸³ D. Varouchas,¹⁴ A. Vartapetian,⁷ K. E. Varvell,¹⁴⁹ V. I. Vassilikopoulos,⁵⁵ F. Vazeille,³³ T. Vazquez Schroeder,⁵³ G. Vegni,^{88a,88b} J. J. Veillet,¹¹⁴ F. Veloso,^{123a} R. Veness,²⁹ S. Veneziano,^{131a} A. Ventura,^{71a,71b} D. Ventura,⁸³ M. Venturi,⁴⁷ N. Venturi,¹⁵⁷ V. Vercesi,^{118a} M. Verducci,¹³⁷ W. Verkerke,¹⁰⁴ J. C. Vermeulen,¹⁰⁴ A. Vest,⁴³ M. C. Vetterli,^{141,e} I. Vichou,¹⁶⁴ T. Vickey,^{144b,hh} O. E. Vickey Boeriu,^{144b} G. H. A. Viehhauser,¹¹⁷ S. Viel,¹⁶⁷ M. Villa,^{19a,19b} M. Villaplana Perez,¹⁶⁶ E. Vilucchi,⁴⁶ M. G. Vincter,²⁸ E. Vinek,²⁹ V. B. Vinogradov,⁶³ M. Virchaux,^{135,a} J. Virzi,¹⁴ O. Vitells,¹⁷⁰ M. Viti,⁴¹ I. Vivarelli,⁴⁷ F. Vives Vaque,² S. Vlachos,⁹ D. Vladoiu,⁹⁷ M. Vlasak,¹²⁶ A. Vogel,²⁰ P. Vokac,¹²⁶ G. Volpi,⁴⁶ M. Volpi,⁸⁵ G. Volpini,^{88a} H. von der Schmitt,⁹⁸ J. von Loeben,⁹⁸ H. von Radziewski,⁴⁷ E. von Toerne,²⁰ V. Vorobel,¹²⁵ V. Vorwerk,¹¹ M. Vos,¹⁶⁶ R. Voss,²⁹ T. T. Voss,¹⁷³ J. H. Vosseveld,⁷² N. Vranjes,¹³⁵ M. Vranjes Milosavljevic,¹⁰⁴ V. Vrba,¹²⁴ M. Vreeswijk,¹⁰⁴ T. Vu Anh,⁴⁷ R. Vuillermet,²⁹ I. Vukotic,¹¹⁴ W. Wagner,¹⁷³ P. Wagner,¹¹⁹ H. Wahlen,¹⁷³ S. Wahrmund,⁴³ J. Wakabayashi,¹⁰⁰ S. Walch,⁸⁶ J. Walder,⁷⁰ R. Walker,⁹⁷ W. Walkowiak,¹⁴⁰ R. Wall,¹⁷⁴ P. Waller,⁷² C. Wang,⁴⁴ H. Wang,¹⁷¹ H. Wang,^{32b,ii} J. Wang,¹⁵⁰ J. Wang,⁵⁴ J. C. Wang,¹³⁷ R. Wang,¹⁰² S. M. Wang,¹⁵⁰ T. Wang,²⁰ A. Warburton,⁸⁴ C. P. Ward,²⁷ M. Warsinsky,⁴⁷ A. Washbrook,⁴⁵ C. Wasicki,⁴¹ P. M. Watkins,¹⁷ A. T. Watson,¹⁷ I. J. Watson,¹⁴⁹ M. F. Watson,¹⁷ G. Watts,¹³⁷ S. Watts,⁸¹ A. T. Waugh,¹⁴⁹ B. M. Waugh,⁷⁶ M. Weber,¹²⁸ M. S. Weber,¹⁶ P. Weber,⁵³ A. R. Weidberg,¹¹⁷ P. Weigell,⁹⁸ J. Weingarten,⁵³ C. Weiser,⁴⁷ H. Wellenstein,²² P. S. Wells,²⁹ T. Wenaus,²⁴ D. Wendland,¹⁵ Z. Weng,^{150,v} T. Wengler,²⁹ S. Wenig,²⁹ N. Wermes,²⁰ M. Werner,⁴⁷ P. Werner,²⁹ M. Werth,¹⁶² M. Wessels,^{57a} J. Wetter,¹⁶⁰ C. Weydert,⁵⁴ K. Whalen,²⁸ S. J. Wheeler-Ellis,¹⁶² A. White,⁷ M. J. White,⁸⁵ S. White,^{121a,121b} S. R. Whitehead,¹¹⁷ D. Whiteson,¹⁶² D. Whittington,⁵⁹ F. Wicek,¹¹⁴ D. Wicke,¹⁷³ F. J. Wickens,¹²⁸ W. Wiedenmann,¹⁷¹ M. WIELERS,¹²⁸ P. Wienemann,²⁰ C. Wigglesworth,⁷⁴ L. A. M. Wiik-Fuchs,⁴⁷ P. A. Wijeratne,⁷⁶ A. Wildauer,¹⁶⁶ M. A. Wildt,^{41,r} I. Wilhelm,¹²⁵ H. G. Wilkens,²⁹ J. Z. Will,⁹⁷ E. Williams,³⁴ H. H. Williams,¹¹⁹ W. Willis,³⁴ S. Willocq,⁸³ J. A. Wilson,¹⁷ M. G. Wilson,¹⁴² A. Wilson,⁸⁶ I. Wingerter-Seez,⁴ S. Winkelmann,⁴⁷ F. Winklmeier,²⁹ M. Wittgen,¹⁴² M. W. Wolter,³⁸ H. Wolters,^{123a,i} W. C. Wong,⁴⁰ G. Wooden,⁸⁶ B. K. Wosiek,³⁸ J. Wotschack,²⁹ M. J. Woudstra,⁸³ K. W. Wozniak,³⁸ K. Wraight,⁵² C. Wright,⁵² M. Wright,⁵² B. Wrona,⁷² S. L. Wu,¹⁷¹ X. Wu,⁴⁸ Y. Wu,^{32b,ij} E. Wulf,³⁴ B. M. Wynne,⁴⁵ S. Xella,³⁵ M. Xiao,¹³⁵ S. Xie,⁴⁷ C. Xu,^{32b,y} D. Xu,¹³⁸ B. Yabsley,¹⁴⁹ S. Yacoob,^{144b} M. Yamada,⁶⁴ H. Yamaguchi,¹⁵⁴ A. Yamamoto,⁶⁴ K. Yamamoto,⁶² S. Yamamoto,¹⁵⁴ T. Yamamura,¹⁵⁴ T. Yamanaka,¹⁵⁴ J. Yamaoka,⁴⁴ T. Yamazaki,¹⁵⁴ Y. Yamazaki,⁶⁵ Z. Yan,²¹ H. Yang,⁸⁶ U. K. Yang,⁸¹ Y. Yang,⁵⁹ Z. Yang,^{145a,145b} S. Yanush,⁹⁰ L. Yao,^{32a} Y. Yao,¹⁴ Y. Yasu,⁶⁴ G. V. Ybeles Smit,¹²⁹ J. Ye,³⁹ S. Ye,²⁴ M. Yilmaz,^{3c} R. Yoosoofmiya,¹²² K. Yorita,¹⁶⁹ R. Yoshida,⁵ C. Young,¹⁴² C. J. Young,¹¹⁷ S. Youssef,²¹ D. Yu,²⁴ J. Yu,⁷ J. Yu,¹¹¹ L. Yuan,⁶⁵ A. Yurkewicz,¹⁰⁵ B. Zabinski,³⁸ R. Zaidan,⁶¹

A. M. Zaitsev,¹²⁷ Z. Zajacova,²⁹ L. Zanello,^{131a,131b} A. Zaytsev,¹⁰⁶ C. Zeitnitz,¹⁷³ M. Zeller,¹⁷⁴ M. Zeman,¹²⁴
 A. Zemla,³⁸ C. Zender,²⁰ O. Zenin,¹²⁷ T. Ženiš,^{143a} Z. Zinonos,^{121a,121b} S. Zenz,¹⁴ D. Zerwas,¹¹⁴
 G. Zevi della Porta,⁵⁶ Z. Zhan,^{32d} D. Zhang,^{32b,ii} H. Zhang,⁸⁷ J. Zhang,⁵ X. Zhang,^{32d} Z. Zhang,¹¹⁴ L. Zhao,¹⁰⁷
 T. Zhao,¹³⁷ Z. Zhao,^{32b} A. Zhemchugov,⁶³ J. Zhong,¹¹⁷ B. Zhou,⁸⁶ N. Zhou,¹⁶² Y. Zhou,¹⁵⁰ C. G. Zhu,^{32d} H. Zhu,⁴¹
 J. Zhu,⁸⁶ Y. Zhu,^{32b} X. Zhuang,⁹⁷ V. Zhuravlov,⁹⁸ D. Zieminska,⁵⁹ R. Zimmermann,²⁰ S. Zimmermann,²⁰
 S. Zimmermann,⁴⁷ M. Ziolkowski,¹⁴⁰ R. Zitoun,⁴ L. Živković,³⁴ V. V. Zmouchko,^{127,a} G. Zobernig,¹⁷¹
 A. Zoccoli,^{19a,19b} M. zur Nedden,¹⁵ V. Zutshi,¹⁰⁵ and L. Zwalinski²⁹

(ATLAS Collaboration)

¹University at Albany, Albany New York, USA

²Department of Physics, University of Alberta, Edmonton AB, Canada

^{3a}Department of Physics, Ankara University, Ankara, Turkey

^{3b}Department of Physics, Dumlupinar University, Kutahya, Turkey

^{3c}Department of Physics, Gazi University, Ankara, Turkey

^{3d}Division of Physics, TOBB University of Economics and Technology, Ankara, Turkey

^{3e}Turkish Atomic Energy Authority, Ankara, Turkey

⁴LAPP, CNRS/IN2P3 and Université de Savoie, Annecy-le-Vieux, France

⁵High Energy Physics Division, Argonne National Laboratory, Argonne Illinois, USA

⁶Department of Physics, University of Arizona, Tucson Arizona, USA

⁷Department of Physics, The University of Texas at Arlington, Arlington Texas, USA

⁸Physics Department, University of Athens, Athens, Greece

⁹Physics Department, National Technical University of Athens, Zografou, Greece

¹⁰Institute of Physics, Azerbaijan Academy of Sciences, Baku, Azerbaijan

¹¹Institut de Física d'Altes Energies and Departament de Física de la Universitat Autònoma de Barcelona and ICREA, Barcelona, Spain

^{12a}Institute of Physics, University of Belgrade, Belgrade, Serbia

^{12b}Vinca Institute of Nuclear Sciences, University of Belgrade, Belgrade, Serbia

¹³Department for Physics and Technology, University of Bergen, Bergen, Norway

¹⁴Physics Division, Lawrence Berkeley National Laboratory and University of California, Berkeley California, USA

¹⁵Department of Physics, Humboldt University, Berlin, Germany

¹⁶Albert Einstein Center for Fundamental Physics and Laboratory for High Energy Physics, University of Bern, Bern, Switzerland

¹⁷School of Physics and Astronomy, University of Birmingham, Birmingham, United Kingdom

^{18a}Department of Physics, Bogazici University, Istanbul, Turkey

^{18b}Division of Physics, Dogus University, Istanbul, Turkey

^{18c}Department of Physics Engineering, Gaziantep University, Gaziantep, Turkey

^{18d}Department of Physics, Istanbul Technical University, Istanbul, Turkey

^{19a}INFN Sezione di Bologna, Italy

^{19b}Dipartimento di Fisica, Università di Bologna, Bologna, Italy

²⁰Physikalisches Institut, University of Bonn, Bonn, Germany

²¹Department of Physics, Boston University, Boston Massachusetts, USA

²²Department of Physics, Brandeis University, Waltham Massachusetts, USA

^{23a}Universidade Federal do Rio De Janeiro COPPE/EE/IF, Rio de Janeiro, Brazil

^{23b}Federal University of Juiz de Fora (UFJF), Juiz de Fora, Brazil

^{23c}Federal University of Sao Joao del Rei (UFSJ), Sao Joao del Rei, Brazil

^{23d}Instituto de Fisica, Universidade de Sao Paulo, Sao Paulo, Brazil

²⁴Physics Department, Brookhaven National Laboratory, Upton New York, USA

^{25a}National Institute of Physics and Nuclear Engineering, Bucharest, Romania

^{25b}University Politehnica Bucharest, Bucharest, Romania

^{25c}West University in Timisoara, Timisoara, Romania

²⁶Departamento de Física, Universidad de Buenos Aires, Buenos Aires, Argentina

²⁷Cavendish Laboratory, University of Cambridge, Cambridge, United Kingdom

²⁸Department of Physics, Carleton University, Ottawa ON, Canada

²⁹CERN, Geneva, Switzerland

³⁰Enrico Fermi Institute, University of Chicago, Chicago Illinois, USA

^{31a}Departamento de Física, Pontificia Universidad Católica de Chile, Santiago, Chile

^{31b}Departamento de Física, Universidad Técnica Federico Santa María, Valparaíso, Chile

^{32a}Institute of High Energy Physics, Chinese Academy of Sciences, Beijing, China

^{32b}Department of Modern Physics, University of Science and Technology of China, Anhui, China

- ^{32c}Department of Physics, Nanjing University, Jiangsu, China
^{32d}School of Physics, Shandong University, Shandong, China
³³Laboratoire de Physique Corpusculaire, Clermont Université and Université Blaise Pascal and CNRS/IN2P3, Aubiere Cedex, France
³⁴Nevis Laboratory, Columbia University, Irvington New York, USA
³⁵Niels Bohr Institute, University of Copenhagen, Kobenhavn, Denmark
^{36a}INFN Gruppo Collegato di Cosenza, Italy
^{36b}Dipartimento di Fisica, Università della Calabria, Arcavata di Rende, Italy
³⁷AGH University of Science and Technology, Faculty of Physics and Applied Computer Science, Krakow, Poland
³⁸The Henryk Niewodniczanski Institute of Nuclear Physics, Polish Academy of Sciences, Krakow, Poland
³⁹Physics Department, Southern Methodist University, Dallas Texas, USA
⁴⁰Physics Department, University of Texas at Dallas, Richardson Texas, USA
⁴¹DESY, Hamburg and Zeuthen, Germany
⁴²Institut für Experimentelle Physik IV, Technische Universität Dortmund, Dortmund, Germany
⁴³Institut für Kern- und Teilchenphysik, Technical University Dresden, Dresden, Germany
⁴⁴Department of Physics, Duke University, Durham North Carolina, USA
⁴⁵SUPA—School of Physics and Astronomy, University of Edinburgh, Edinburgh, United Kingdom
⁴⁶INFN Laboratori Nazionali di Frascati, Frascati, Italy
⁴⁷Fakultät für Mathematik und Physik, Albert-Ludwigs-Universität, Freiburg i.Br., Germany
⁴⁸Section de Physique, Université de Genève, Geneva, Switzerland
^{49a}INFN Sezione di Genova, Italy
^{49b}Dipartimento di Fisica, Università di Genova, Genova, Italy
^{50a}E.Andronikashvili Institute of Physics, Tbilisi State University, Tbilisi, Georgia
^{50b}High Energy Physics Institute, Tbilisi State University, Tbilisi, Georgia
⁵¹II Physikalisches Institut, Justus-Liebig-Universität Giessen, Giessen, Germany
⁵²SUPA—School of Physics and Astronomy, University of Glasgow, Glasgow, United Kingdom
⁵³II Physikalisches Institut, Georg-August-Universität, Göttingen, Germany
⁵⁴Laboratoire de Physique Subatomique et de Cosmologie, Université Joseph Fourier and CNRS/IN2P3 and Institut National Polytechnique de Grenoble, Grenoble, France
⁵⁵Department of Physics, Hampton University, Hampton Virginia, USA
⁵⁶Laboratory for Particle Physics and Cosmology, Harvard University, Cambridge Massachusetts, USA
^{57a}Kirchhoff-Institut für Physik, Ruprecht-Karls-Universität Heidelberg, Heidelberg, Germany
^{57b}Physikalisches Institut, Ruprecht-Karls-Universität Heidelberg, Heidelberg, Germany
^{57c}ZITI Institut für technische Informatik, Ruprecht-Karls-Universität Heidelberg, Mannheim, Germany
⁵⁸Faculty of Applied Information Science, Hiroshima Institute of Technology, Hiroshima, Japan
⁵⁹Department of Physics, Indiana University, Bloomington Indiana, USA
⁶⁰Institut für Astro- und Teilchenphysik, Leopold-Franzens-Universität, Innsbruck, Austria
⁶¹University of Iowa, Iowa City Iowa, USA
⁶²Department of Physics and Astronomy, Iowa State University, Ames Iowa, USA
⁶³Joint Institute for Nuclear Research, JINR Dubna, Dubna, Russia, USA
⁶⁴KEK, High Energy Accelerator Research Organization, Tsukuba, Japan
⁶⁵Graduate School of Science, Kobe University, Kobe, Japan
⁶⁶Faculty of Science, Kyoto University, Kyoto, Japan
⁶⁷Kyoto University of Education, Kyoto, Japan
⁶⁸Department of Physics, Kyushu University, Fukuoka, Japan
⁶⁹Instituto de Física La Plata, Universidad Nacional de La Plata and CONICET, La Plata, Argentina
⁷⁰Physics Department, Lancaster University, Lancaster, United Kingdom
^{71a}INFN Sezione di Lecce, Italy
^{71b}Dipartimento di Matematica e Fisica, Università del Salento, Lecce, Italy
⁷²Oliver Lodge Laboratory, University of Liverpool, Liverpool, United Kingdom
⁷³Department of Physics, Jožef Stefan Institute and University of Ljubljana, Ljubljana, Slovenia
⁷⁴School of Physics and Astronomy, Queen Mary University of London, London, United Kingdom
⁷⁵Department of Physics, Royal Holloway University of London, Surrey, United Kingdom
⁷⁶Department of Physics and Astronomy, University College London, London, United Kingdom
⁷⁷Laboratoire de Physique Nucléaire et de Hautes Energies, UPMC and Université Paris-Diderot and CNRS/IN2P3, Paris, France
⁷⁸Fysiska institutionen, Lunds universitet, Lund, Sweden
⁷⁹Departamento de Física Teórica C-15, Universidad Autónoma de Madrid, Madrid, Spain
⁸⁰Institut für Physik, Universität Mainz, Mainz, Germany
⁸¹School of Physics and Astronomy, University of Manchester, Manchester, United Kingdom
⁸²CPPM, Aix-Marseille Université and CNRS/IN2P3, Marseille, France
⁸³Department of Physics, University of Massachusetts, Amherst Massachusetts, USA

- ⁸⁴*Department of Physics, McGill University, Montreal QC, Canada*
⁸⁵*School of Physics, University of Melbourne, Victoria, Australia*
⁸⁶*Department of Physics, The University of Michigan, Ann Arbor Michigan, USA*
⁸⁷*Department of Physics and Astronomy, Michigan State University, East Lansing Michigan, USA*
^{88a}*INFN Sezione di Milano, Italy*
^{88b}*Dipartimento di Fisica, Università di Milano, Milano, Italy*
⁸⁹*B.I. Stepanov Institute of Physics, National Academy of Sciences of Belarus, Minsk, Republic of Belarus*
⁹⁰*National Scientific and Educational Centre for Particle and High Energy Physics, Minsk, Republic of Belarus*
⁹¹*Department of Physics, Massachusetts Institute of Technology, Cambridge Massachusetts, USA*
⁹²*Group of Particle Physics, University of Montreal, Montreal QC, Canada*
⁹³*P.N. Lebedev Institute of Physics, Academy of Sciences, Moscow, Russia*
⁹⁴*Institute for Theoretical and Experimental Physics (ITEP), Moscow, Russia*
⁹⁵*Moscow Engineering and Physics Institute (MEPhI), Moscow, Russia*
⁹⁶*Skobeltsyn Institute of Nuclear Physics, Lomonosov Moscow State University, Moscow, Russia*
⁹⁷*Fakultät für Physik, Ludwig-Maximilians-Universität München, München, Germany*
⁹⁸*Max-Planck-Institut für Physik (Werner-Heisenberg-Institut), München, Germany*
⁹⁹*Nagasaki Institute of Applied Science, Nagasaki, Japan*
¹⁰⁰*Graduate School of Science, Nagoya University, Nagoya, Japan*
^{101a}*INFN Sezione di Napoli, Italy*
^{101b}*Dipartimento di Scienze Fisiche, Università di Napoli, Napoli, Italy*
¹⁰²*Department of Physics and Astronomy, University of New Mexico, Albuquerque New Mexico, USA*
¹⁰³*Institute for Mathematics, Astrophysics and Particle Physics, Radboud University Nijmegen/Nikhef, Nijmegen, Netherlands*
¹⁰⁴*Nikhef National Institute for Subatomic Physics and University of Amsterdam, Amsterdam, Netherlands*
¹⁰⁵*Department of Physics, Northern Illinois University, DeKalb Illinois, USA*
¹⁰⁶*Budker Institute of Nuclear Physics, SB RAS, Novosibirsk, Russia*
¹⁰⁷*Department of Physics, New York University, New York New York, USA*
¹⁰⁸*Ohio State University, Columbus Ohio, USA*
¹⁰⁹*Faculty of Science, Okayama University, Okayama, Japan*
¹¹⁰*Homer L. Dodge Department of Physics and Astronomy, University of Oklahoma, Norman Oklahoma, USA*
¹¹¹*Department of Physics, Oklahoma State University, Stillwater Oklahoma, USA*
¹¹²*Palacký University, RCPTM, Olomouc, Czech Republic*
¹¹³*Center for High Energy Physics, University of Oregon, Eugene Oregon, USA*
¹¹⁴*LAL, Univ. Paris-Sud and CNRS/IN2P3, Orsay, France*
¹¹⁵*Graduate School of Science, Osaka University, Osaka, Japan*
¹¹⁶*Department of Physics, University of Oslo, Oslo, Norway*
¹¹⁷*Department of Physics, Oxford University, Oxford, United Kingdom*
^{118a}*INFN Sezione di Pavia, Italy*
^{118b}*Dipartimento di Fisica, Università di Pavia, Pavia, Italy*
¹¹⁹*Department of Physics, University of Pennsylvania, Philadelphia Pennsylvania, USA*
¹²⁰*Petersburg Nuclear Physics Institute, Gatchina, Russia*
^{121a}*INFN Sezione di Pisa, Italy*
^{121b}*Dipartimento di Fisica E. Fermi, Università di Pisa, Pisa, Italy*
¹²²*Department of Physics and Astronomy, University of Pittsburgh, Pittsburgh Pennsylvania, USA*
^{123a}*Laboratorio de Instrumentacao e Fisica Experimental de Partículas—LIP, Lisboa, Portugal*
^{123b}*Departamento de Fisica Teorica y del Cosmos and CAFPE, Universidad de Granada, Granada, Spain*
¹²⁴*Institute of Physics, Academy of Sciences of the Czech Republic, Praha, Czech Republic*
¹²⁵*Faculty of Mathematics and Physics, Charles University in Prague, Praha, Czech Republic*
¹²⁶*Czech Technical University in Prague, Praha, Czech Republic*
¹²⁷*State Research Center Institute for High Energy Physics, Protvino, Russia*
¹²⁸*Particle Physics Department, Rutherford Appleton Laboratory, Didcot, United Kingdom*
¹²⁹*Physics Department, University of Regina, Regina SK, Canada*
¹³⁰*Ritsumeikan University, Kusatsu, Shiga, Japan*
^{131a}*INFN Sezione di Roma I, Italy*
^{131b}*Dipartimento di Fisica, Università La Sapienza, Roma, Italy*
^{132a}*INFN Sezione di Roma Tor Vergata, Italy*
^{132b}*Dipartimento di Fisica, Università di Roma Tor Vergata, Roma, Italy*
^{133a}*INFN Sezione di Roma Tre, Italy*
^{133b}*Dipartimento di Fisica, Università Roma Tre, Roma, Italy*
^{134a}*Faculté des Sciences Ain Chock, Réseau Universitaire de Physique des Hautes Energies—Université Hassan II, Casablanca, Morocco*
^{134b}*Centre National de l'Energie des Sciences Techniques Nucleaires, Rabat, Morocco*

- ^{134c}*Faculté des Sciences Semailia, Université Cadi Ayyad, LPHEA-Marrakech, Morocco*
^{134d}*Faculté des Sciences, Université Mohamed Premier and LPTPM, Oujda, Morocco*
^{134e}*Faculty of sciences, Mohammed V-Agdal University, Rabat, Morocco*
¹³⁵*DSM/IRFU (Institut de Recherches sur les Lois Fondamentales de l'Univers), CEA Saclay (Commissariat à l'Energie Atomique), Gif-sur-Yvette, France*
¹³⁶*Santa Cruz Institute for Particle Physics, University of California Santa Cruz, Santa Cruz California, USA*
¹³⁷*Department of Physics, University of Washington, Seattle Washington, USA*
¹³⁸*Department of Physics and Astronomy, University of Sheffield, Sheffield, United Kingdom*
¹³⁹*Department of Physics, Shinshu University, Nagano, Japan*
¹⁴⁰*Fachbereich Physik, Universität Siegen, Siegen, Germany*
¹⁴¹*Department of Physics, Simon Fraser University, Burnaby BC, Canada*
¹⁴²*SLAC National Accelerator Laboratory, Stanford California, USA*
^{143a}*Faculty of Mathematics, Physics & Informatics, Comenius University, Bratislava, Slovak Republic*
^{143b}*Department of Subnuclear Physics, Institute of Experimental Physics of the Slovak Academy of Sciences, Kosice, Slovak Republic*
^{144a}*Department of Physics, University of Johannesburg, Johannesburg, South Africa*
^{144b}*School of Physics, University of the Witwatersrand, Johannesburg, South Africa*
^{145a}*Department of Physics, Stockholm University, Sweden*
^{145b}*The Oskar Klein Centre, Stockholm, Sweden*
¹⁴⁶*Physics Department, Royal Institute of Technology, Stockholm, Sweden*
¹⁴⁷*Departments of Physics & Astronomy and Chemistry, Stony Brook University, Stony Brook New York, USA*
¹⁴⁸*Department of Physics and Astronomy, University of Sussex, Brighton, United Kingdom*
¹⁴⁹*School of Physics, University of Sydney, Sydney, Australia*
¹⁵⁰*Institute of Physics, Academia Sinica, Taipei, Taiwan*
¹⁵¹*Department of Physics, Technion: Israel Inst. of Technology, Haifa, Israel*
¹⁵²*Raymond and Beverly Sackler School of Physics and Astronomy, Tel Aviv University, Tel Aviv, Israel*
¹⁵³*Department of Physics, Aristotle University of Thessaloniki, Thessaloniki, Greece*
¹⁵⁴*International Center for Elementary Particle Physics and Department of Physics, The University of Tokyo, Tokyo, Japan*
¹⁵⁵*Graduate School of Science and Technology, Tokyo Metropolitan University, Tokyo, Japan*
¹⁵⁶*Department of Physics, Tokyo Institute of Technology, Tokyo, Japan*
¹⁵⁷*Department of Physics, University of Toronto, Toronto ON, Canada*
^{158a}*TRIUMF, Vancouver BC, Canada*
^{158b}*Department of Physics and Astronomy, York University, Toronto ON, Canada*
¹⁵⁹*Institute of Pure and Applied Sciences, University of Tsukuba, 1-1-1 Tennodai, Tsukuba, Ibaraki 305-8571, Japan*
¹⁶⁰*Science and Technology Center, Tufts University, Medford Massachusetts, USA*
¹⁶¹*Centro de Investigaciones, Universidad Antonio Narino, Bogota, Colombia*
¹⁶²*Department of Physics and Astronomy, University of California Irvine, Irvine California, USA*
^{163a}*INFN Gruppo Collegato di Udine, Italy*
^{163b}*ICTP, Trieste, Italy*
^{163c}*Dipartimento di Chimica, Fisica e Ambiente, Università di Udine, Udine, Italy*
¹⁶⁴*Department of Physics, University of Illinois, Urbana Illinois, USA*
¹⁶⁵*Department of Physics and Astronomy, University of Uppsala, Uppsala, Sweden*
¹⁶⁶*Instituto de Física Corpuscular (IFIC) and Departamento de Física Atómica, Molecular y Nuclear and Departamento de Ingeniería Electrónica and Instituto de Microelectrónica de Barcelona (IMB-CNM), University of Valencia and CSIC, Valencia, Spain*
¹⁶⁷*Department of Physics, University of British Columbia, Vancouver BC, Canada*
¹⁶⁸*Department of Physics and Astronomy, University of Victoria, Victoria BC, Canada*
¹⁶⁹*Waseda University, Tokyo, Japan*
¹⁷⁰*Department of Particle Physics, The Weizmann Institute of Science, Rehovot, Israel*
¹⁷¹*Department of Physics, University of Wisconsin, Madison Wisconsin, USA*
¹⁷²*Fakultät für Physik und Astronomie, Julius-Maximilians-Universität, Würzburg, Germany*
¹⁷³*Fachbereich C Physik, Bergische Universität Wuppertal, Wuppertal, Germany*
¹⁷⁴*Department of Physics, Yale University, New Haven Connecticut, USA*
¹⁷⁵*Yerevan Physics Institute, Yerevan, Armenia*
¹⁷⁶*Domaine scientifique de la Doua, Centre de Calcul CNRS/IN2P3, Villeurbanne Cedex, France*

^aDeceased.

^bAlso at Laboratorio de Instrumentacao e Fisica Experimental de Particulas—LIP, Lisboa, Portugal.

^cAlso at Faculdade de Ciencias and CFNUL, Universidade de Lisboa, Lisboa, Portugal.

^dAlso at Particle Physics Department, Rutherford Appleton Laboratory, Didcot, United Kingdom.

^eAlso at TRIUMF, Vancouver BC, Canada.

^fAlso at Department of Physics, California State University, Fresno CA, USA.

- ^gAlso at Novosibirsk State University, Novosibirsk, Russia.
- ^hAlso at Fermilab, Batavia IL, USA.
- ⁱAlso at Department of Physics, University of Coimbra, Coimbra, Portugal.
- ^jAlso at Università di Napoli Parthenope, Napoli, Italy.
- ^kAlso at Institute of Particle Physics (IPP), Canada.
- ^lAlso at Department of Physics, Middle East Technical University, Ankara, Turkey.
- ^mAlso at Louisiana Tech University, Ruston LA, USA.
- ⁿAlso at Department of Physics and Astronomy, University College London, London, United Kingdom.
- ^oAlso at Group of Particle Physics, University of Montreal, Montreal QC, Canada.
- ^pAlso at Department of Physics, University of Cape Town, Cape Town, South Africa.
- ^qAlso at Institute of Physics, Azerbaijan Academy of Sciences, Baku, Azerbaijan.
- ^rAlso at Institut für Experimentalphysik, Universität Hamburg, Hamburg, Germany.
- ^sAlso at Manhattan College, NY NY, USA.
- ^tAlso at School of Physics, Shandong University, Shandong, China.
- ^uAlso at CPPM, Aix-Marseille Université and CNRS/IN2P3, Marseille, France.
- ^vAlso at School of Physics and Engineering, Sun Yat-sen University, Guanzhou, China.
- ^wAlso at Academia Sinica Grid Computing, Institute of Physics, Academia Sinica, Taipei, Taiwan.
- ^xAlso at Dipartimento di Fisica, Università La Sapienza, Roma, Italy.
- ^yAlso at DSM/IRFU (Institut de Recherches sur les Lois Fondamentales de l'Univers), CEA Saclay (Commissariat à l'Energie Atomique), Gif-sur-Yvette, France.
- ^zAlso at Section de Physique, Université de Genève, Geneva, Switzerland.
- ^{aa}Also at Departamento de Fisica, Universidade de Minho, Braga, Portugal.
- ^{bb}Also at Department of Physics and Astronomy, University of South Carolina, Columbia SC, USA
- ^{cc}Also at Institute for Particle and Nuclear Physics, Wigner Research Centre for Physics, Budapest, Hungary.
- ^{dd}Also at California Institute of Technology, Pasadena CA, USA.
- ^{ee}Also at Institute of Physics, Jagiellonian University, Krakow, Poland.
- ^{ff}Also at LAL, Univ. Paris-Sud and CNRS/IN2P3, Orsay, France.
- ^{gg}Also at Department of Physics and Astronomy, University of Sheffield, Sheffield, United Kingdom.
- ^{hh}Also at Department of Physics, Oxford University, Oxford, United Kingdom.
- ⁱⁱAlso at Institute of Physics, Academia Sinica, Taipei, Taiwan.
- ^{jj}Also at Department of Physics, The University of Michigan, Ann Arbor MI, USA.